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A comparison of methods for controlling familywise error: post-hoc analyses for factorial designs

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N	ESAB	ESSC	ESSE	METHOD			
15	.60	.73485	.60000	FISH <	MB	MBB	BON
				KEP <			BON
				TRow <			BON
15	.60	.74245	.65574	FISH <			BON
15	.60	.74245	.70000				
15	.60	.79609	.65574	FISH <			BON
				KEP <			BON
15	.60	.85732	.70000				
15	.60	.88795	.75664				
15	.60	.90156	.75664				
15	.60	.90156	.85001				
15	.60	1.04100	.85001				

N	ESAB	ESSC	ESSE	METHOD					
15	.60	.52052	.85001	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
15	.60	.53032	.55678	FISH <		MB	MBB	BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
15	.60	.58176	.52202	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
15	.60	.63639	.52202	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
15	.60	.63639	.55678	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
15	.60	.63639	.60000	FISH <			MBB	BON	TRow
				KEP <				BON	TRow
15	.60	.63639	.65574	FISH <					TRow
				KEP <					TRow
15	.60	.63639	.75664	FISH <					TRow
15				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
15	.60	.67361	.55678	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <			MBB	BON	
15	.60	.67361	.75664						

N	ESAB	ESSC	ESSE	METHOD				
15	.60	.26517	.75664	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.30619	.65574	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.36742	.60000	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.37123	.52202	FISH <			BON	TRow
				KEP <			BON	TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.42866	.55678	FISH <			BON	TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.42866	.70000	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.48990	.65574	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.52052	.52202	FISH <	MB	MBB	BON	TRow
				KEP <	MB	MBB	BON	TRow
				MB <			BON	
				MBB <			BON	

N	ESAB	ESSC	ESSE	METHOD				
15	.40	.64300	.56789	FISH <	MB	MBB	BON	TRow
				KEP <	MB	MBB	BON	
				MB <			BON	
				TRow <			BON	
15	.40	.68943	.56789	FISH <	MB	MBB	BON	TRow
				KEP <	MB	MBB	BON	
				MB <			BON	
				MBB <			BON	
				TRow <			BON	
15	.40	.68943	.65000	FISH <			BON	
15	.40	.79609	.65000	FISH <			BON	
				KEP <			BON	
				TRow <			BON	
15	.60	.06124	.52202					
15	.60	.10606	.55678	FISH <				TRow
				KEP <				TRow
15	.60	.10606	.65574	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.21433	.75664	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.24495	.55678	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
15	.60	.26517	.52202	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow

N	ESAB	ESSC	ESSE	METHOD						
15	.40	.42426	.56789	FISH	<					TRow
				KEP	<					TRow
				MB	<					TRow
				MBB	<					TRow
				BON	<					TRow
15	.40	.42866	.36056	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.48990	.40000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.53032	.45826	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<			MBB	BON	
15	.40	.53032	.50000	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	
15	.40	.55114	.45826	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.55114	.56789	FISH	<		MB	MBB	BON	TRow
				KEP	<				BON	TRow
				MB	<					TRow
				MBB	<					TRow
15	.40	.61238	.50000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	

N	ESAB	ESSC	ESSE	METHOD						
15	.40	.31819	.36056	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
15	.40	.33681	.35000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
15	.40	.36742	.45826	FISH	<		MB	MBB	BON	
15	.40	.36742	.45826	KEP	<				BON	TRow
				MB	<					TRow
				MBB	<					TRow
15	.40	.39804	.35000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.39804	.65000	FISH	<					TRow
				KEP	<					TRow
				MB	<					TRow
				MBB	<					TRow
				BON	<					TRow
15	.40	.42426	.35000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.42426	.36056	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.40	.42426	.40000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	
15	.40	.42426	.45826	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	TRow
				MBB	<				BON	TRow

N	ESAB	ESSC	ESSE	METHOD					
15	.25	.53032	.43302	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
15	.25	.53032	.50000	FISH <		MB	MBB	BON	TRow
				KEP <				BON	TRow
15	.25	.61238	.50000	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				TRow <				BON	
15	.40	.06124	.35000						
15	.40	.09186	.56789						
15	.40	.10606	.36056						
15	.40	.10606	.45826	FISH <					TRow
15	.40	.12248	.36056	FISH <					TRow
15	.40	.15910	.35000	FISH <					TRow
				KEP <					TRow
15	.40	.18372	.45826	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
15	.40	.24495	.40000	FISH <				BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
15	.40	.26517	.35000	FISH <		MB	MBB	BON	TRow
				KEP <			MBB	BON	TRow
15	.40	.26517	.56789	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
15	.40	.30619	.36056	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
15	.40	.30619	.50000	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow

N	ESAB	ESSC	ESSE	METHOD						
15	.25	.26517	.43302	FISH	<					TRow
				KEP	<					TRow
				MB	<					TRow
				MBB	<					TRow
15	.25	.27556	.31225	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
15	.25	.30619	.25000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				TRow	<		MB	MBB	BON	
15	.25	.30619	.50000	FISH	<					TRow
				KEP	<					TRow
				MB	<					TRow
				MBB	<					TRow
				BON	<					TRow
15	.25	.36742	.31225	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.25	.37123	.31225	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.25	.37123	.35000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	
15	.25	.42866	.35000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<		MB	MBB	BON	
15	.25	.45928	.43302	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	

N	ESAB	ESSC	ESSE	METHOD						
8	.60	.88795	.75664	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	
8	.60	.90156	.75664	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				MB	<				BON	
				MBB	<				BON	
				TRow	<				BON	
8	.60	.90156	.85001	FISH	<				BON	TRow
				KEP	<				BON	
8	.60	1.04100	.85001	FISH	<		MB	MBB	BON	
				KEP	<				BON	
				TRow	<				BON	
15	.25	.03062	.21795							
15	.25	.09186	.31225							
15	.25	.10606	.21795							
15	.25	.10606	.31225							
15	.25	.15309	.25000	FISH	<				BON	TRow
15	.25	.15910	.21795	FISH	<		MB	MBB	BON	TRow
				KEP	<				BON	
15	.25	.21433	.21795	FISH	<		MB	MBB	BON	TRow
				KEP	<				BON	
15	.25	.21433	.35000	FISH	<				BON	TRow
				KEP	<					TRow
15	.25	.24495	.21795	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				TRow	<				BON	
15	.25	.26517	.21795	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				TRow	<				BON	
15	.25	.26517	.25000	FISH	<	KEP	MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	
				TRow	<				BON	
15	.25	.26517	.31225	FISH	<		MB	MBB	BON	TRow
				KEP	<		MB	MBB	BON	TRow

N	ESAB	ESSC	ESSE	METHOD					
8	.60	.63639	.75664	FISH <				BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
8	.60	.67361	.55678	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.60	.67361	.75664	FISH <				BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
8	.60	.73485	.60000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		M	MBB	BON	
8	.60	.74245	.65574	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.60	.74245	.70000	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.60	.79609	.65574	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.60	.85732	.70000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	

N	ESAB	ESSC	ESSE	METHOD					
8	.60	.52052	.52202	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.60	.52052	.85001	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
8	.60	.53032	.55678	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
8	.60	.58176	.52202	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.60	.63639	.52202	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.60	.63639	.55678	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.60	.63639	.60000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.60	.63639	.65574	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	

N	ESAB	ESSC	ESSE	METHOD				
8	.60	.24495	.55678	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
8	.60	.26517	.52202	FISH <			BON	TRow
				KEP <				TRow
				MB <				TRow
8	.60	.26517	.75664	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
8	.60	.30619	.65574	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
8	.60	.36742	.60000	FISH <			BON	TRow
				KEP <			BON	TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
8	.60	.37123	.52202	FISH <	MB	MBB	BON	TRow
				KEP <			BON	TRow
				MB <				TRow
				MBB <				TRow
8	.60	.42866	.55678	FISH <	MB	MBB	BON	TRow
				KEP <		MBB	BON	TRow
				MB <				TRow
				MBB <				TRow
8	.60	.42866	.70000	FISH <				TRow
				KEP <				TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow
8	.60	.48990	.65574	FISH <	MB	MBB	BON	TRow
				KEP <			BON	TRow
				MB <				TRow
				MBB <				TRow
				BON <				TRow

N	ESAB	ESSC	ESSE	METHOD					
8	.40	.55114	.56789	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
8	.40	.61238	.50000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.40	.64300	.56789	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.40	.68943	.56789	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.40	.68943	.65000	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.40	.79609	.65000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.60	.06124	.52202						
8	.60	.10606	.55678						
8	.60	.10606	.65574						
8	.60	.21433	.75664	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow

N	ESAB	ESSC	ESSE	METHOD					
8	.40	.42426	.36056	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				TRow <			MBB	BON	
8	.40	.42426	.40000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				TRow <				BON	
8	.40	.42426	.45826	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
8	.40	.42426	.56789	FISH <		MB	MBB	BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
8	.40	.42866	.36056	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				TRow <		MB	MBB	BON	
8	.40	.48990	.40000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.40	.53032	.45826	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	
8	.40	.53032	.50000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
				MB <				BON	
				MBB <				BON	
				TRow <				BON	
8	.40	.55114	.45826	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				MBB <				BON	
				TRow <		MB	MBB	BON	

N	ESAB	ESSC	ESSE	METHOD					
8	.40	.06124	.35000						
8	.40	.09186	.56789						
8	.40	.10606	.36056						
8	.40	.10606	.45826						
8	.40	.12248	.36056						
8	.40	.15910	.35000	FISH <				BON	
8	.40	.18372	.45826	FISH <					TRow
8	.40	.24495	.40000	FISH <		MB	MBB	BON	TRow
				KEP <				BON	TRow
8	.40	.26517	.35000	FISH <		MB	MBB	BON	TRow
				KEP <				BON	
8	.40	.26517	.56789	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
8	.40	.30619	.36056	FISH <		MB	MBB	BON	TRow
				KEP <			MBB	BON	TRow
8	.40	.30619	.50000	FISH <				BON	TRow
				KEP <				BON	TRow
				MB <					TRow
				MBB <					TRow
8	.40	.31819	.36056	FISH <		MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
8	.40	.33681	.35000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	TRow
8	.40	.39804	.35000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				TRow <				BON	
8	.40	.39804	.65000	FISH <					TRow
				KEP <					TRow
				MB <					TRow
				MBB <					TRow
				BON <					TRow
8	.40	.42426	.35000	FISH <	KEP	MB	MBB	BON	TRow
				KEP <		MB	MBB	BON	
				MB <				BON	
				TRow <		MB	MBB	BON	

N	ESAB	ESSC	ESSE	METHOD				
8	.25	.03062	.21795					
8	.25	.09186	.31225					
8	.25	.10606	.21795					
8	.25	.10606	.31225					
8	.25	.15309	.25000					
8	.25	.15910	.21795	FISH <			BON	
8	.25	.21433	.21795	FISH <			BON	
8	.25	.21433	.35000					
8	.25	.24495	.21795	FISH <	MB	MBB	BON	TRow
8	.25	.26517	.21795	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
8	.25	.26517	.25000	FISH <	MB	MBB	BON	
				KEP <			BON	
8	.25	.26517	.31225	FISH <	MB	MBB	BON	
8	.25	.26517	.43302					
8	.25	.27556	.31225	FISH <			BON	
8	.25	.30619	.25000	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
8	.25	.30619	.50000					
8	.25	.36742	.31225	FISH <	MB	MBB	BON	TRow
				KEP <		MBB	BON	
				TRow <			BON	
8	.25	.37123	.31225	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
				TRow <			BON	
8	.25	.37123	.35000	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
8	.25	.42866	.35000	FISH <	MB	MBB	BON	TRow
				KEP <	MB	MBB	BON	
				TRow <			BON	
8	.25	.45928	.43302	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
8	.25	.53032	.43302	FISH <	MB	MBB	BON	TRow
				KEP <		MBB	BON	
				TRow <			BON	
8	.25	.53032	.50000	FISH <	MB	MBB	BON	TRow
				KEP <			BON	
8	.25	.61238	.50000	FISH <	MB	MBB	BON	
				KEP <			BON	
				TRow <			BON	

APPENDIX E:

DIFFERENCES IN TYPE II

ERROR AMONG TECHNIQUES

The following table identified differences in Type II error of greater than .05. When no techniques are presented, no differences of greater than .05 exist. Where differences do occur, all techniques listed to the right of the "<" have higher Type II error rates than that technique to the left of the "<".

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
15	.60	.75664	.67361	PLAN	.0000	.0000	.0408	.0408
				FISH	.0000	.0000	.0408	.0408
				KEP	.0000	.0035	.0379	.0414
				MB	.0000	.0094	.0348	.0442
				MBB	.0000	.0099	.0345	.0444
				BON	.0000	.0166	.0316	.0482
				TRow	.0000	.0035	.0849	.0884
				TOvl	.0000	.0000	.3930	.3930
15	.60	.75664	.88795	PLAN	.0000	.0000	.0017	.0017
				FISH	.0000	.0000	.0017	.0017
				KEP	.0000	.0035	.0004	.0039
				MB	.0000	.0094	.0001	.0095
				MBB	.0000	.0099	.0000	.0099
				BON	.0000	.0166	.0000	.0166
				TRow	.0000	.0035	.0024	.0059
				TOvl	.0000	.0000	.0771	.0771
15	.60	.75664	.90156	PLAN	.0000	.0000	.0013	.0013
				FISH	.0000	.0000	.0013	.0013
				KEP	.0000	.0033	.0003	.0036
				MB	.0000	.0080	.0003	.0083
				MBB	.0000	.0085	.0003	.0088
				BON	.0000	.0175	.0001	.0176
				TRow	.0000	.0033	.0015	.0048
				TOvl	.0000	.0000	.0656	.0656
15	.60	.85001	.52052	PLAN	.0000	.0000	.1858	.1858
				FISH	.0000	.0000	.1858	.1858
				KEP	.0000	.0006	.1853	.1859
				MB	.0000	.0017	.1843	.1860
				MBB	.0000	.0017	.1843	.1860
				BON	.0000	.0032	.1830	.1862
				TRow	.0000	.0006	.3092	.3098
				TOvl	.0000	.0000	.7136	.7136
15	.60	.85001	.90156	PLAN	.0000	.0000	.0012	.0012
				FISH	.0000	.0000	.0012	.0012
				KEP	.0000	.0004	.0010	.0014
				MB	.0000	.0011	.0009	.0020
				MBB	.0000	.0013	.0009	.0022
				BON	.0000	.0031	.0008	.0039
				TRow	.0000	.0004	.0046	.0050
				TOvl	.0000	.0000	.0666	.0666
15	.60	.85001	1.04100	PLAN	.0000	.0000	.0000	.0000
				FISH	.0000	.0000	.0000	.0000
				KEP	.0000	.0006	.0000	.0006
				MB	.0000	.0017	.0000	.0017
				MBB	.0000	.0017	.0000	.0017
				BON	.0000	.0032	.0000	.0032
				TRow	.0000	.0006	.0002	.0008
				TOvl	.0000	.0000	.0125	.0125

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.60	.70000	.42866	PLAN	.0000	.0000	.3511	.3511
				FISH	.0000	.0000	.3511	.3511
				KEP	.0000	.0096	.3417	.3513
				MB	.0000	.0221	.3308	.3529
				MBB	.0000	.0235	.3296	.3531
				BON	.0000	.0377	.3190	.3567
				TRow	.0000	.0096	.4962	.5058
				TOvl	.0000	.0000	.8617	.8617
15	.60	.70000	.74245	PLAN	.0000	.0000	.0170	.0170
				FISH	.0000	.0000	.0170	.0170
				KEP	.0000	.0080	.0122	.0202
				MB	.0000	.0231	.0084	.0315
				MBB	.0000	.0242	.0082	.0324
				BON	.0000	.0380	.0070	.0450
				TRow	.0000	.0080	.0350	.0430
				TOvl	.0000	.0000	.2616	.2616
15	.60	.70000	.85732	PLAN	.0000	.0000	.0037	.0037
				FISH	.0000	.0000	.0037	.0037
				KEP	.0000	.0096	.0003	.0099
				MB	.0000	.0221	.0001	.0222
				MBB	.0000	.0235	.0001	.0236
				BON	.0000	.0377	.0000	.0377
				TRow	.0000	.0096	.0016	.0112
				TOvl	.0000	.0000	.1048	.1048
15	.60	.75664	.21433	PLAN	.0000	.0000	.7816	.7816
				FISH	.0000	.0000	.7816	.7816
				KEP	.0000	.0035	.7781	.7816
				MB	.0000	.0094	.7724	.7818
				MBB	.0000	.0099	.7719	.7818
				BON	.0000	.0166	.7652	.7818
				TRow	.0000	.0035	.8802	.8837
				TOvl	.0000	.0000	.9870	.9870
15	.60	.75664	.26517	PLAN	.0000	.0000	.6981	.6981
				FISH	.0000	.0000	.6981	.6981
				KEP	.0000	.0033	.6948	.6981
				MB	.0000	.0080	.6901	.6981
				MBB	.0000	.0085	.6896	.6981
				BON	.0000	.0175	.6813	.6988
				TRow	.0000	.0033	.8156	.8189
				TOvl	.0000	.0000	.9766	.9766
15	.60	.75664	.63639	PLAN	.0000	.0000	.0625	.0625
				FISH	.0000	.0000	.0625	.0625
				KEP	.0000	.0033	.0601	.0634
				MB	.0000	.0080	.0570	.0650
				MBB	.0000	.0085	.0567	.0652
				BON	.0000	.0175	.0524	.0699
				TRow	.0000	.0033	.1265	.1298
				TOvl	.0000	.0000	.4704	.4704

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.60	.65574	.10606	PLAN	.0000	.0000	.9057	.9057
				FISH	.0000	.0000	.9057	.9057
				KEP	.0000	.0188	.8869	.9057
				MB	.0000	.0427	.8631	.9058
				MBB	.0000	.0448	.8610	.9058
				BON	.0000	.0692	.8371	.9063
				TRow	.0000	.0188	.9381	.9569
				TOvl	.0000	.0000	.9978	.9978
15	.60	.65574	.30619	PLAN	.0000	.0000	.6159	.6159
				FISH	.0000	.0000	.6159	.6159
				KEP	.0000	.0166	.5997	.6163
				MB	.0000	.0401	.5780	.6181
				MBB	.0000	.0415	.5766	.6181
				BON	.0000	.0724	.5495	.6219
				TRow	.0000	.0166	.7322	.7488
				TOvl	.0000	.0000	.9599	.9599
15	.60	.65574	.48990	PLAN	.0000	.0000	.2377	.2377
				FISH	.0000	.0000	.2377	.2377
				KEP	.0000	.0166	.2224	.2390
				MB	.0000	.0401	.2053	.2454
				MBB	.0000	.0415	.2044	.2459
				BON	.0000	.0724	.1864	.2588
				TRow	.0000	.0166	.3561	.3727
				TOvl	.0000	.0000	.7709	.7709
15	.60	.65574	.63639	PLAN	.0000	.0000	.0623	.0623
				FISH	.0000	.0000	.0623	.0623
				KEP	.0000	.0188	.0492	.0680
				MB	.0000	.0427	.0405	.0832
				MBB	.0000	.0448	.0395	.0843
				BON	.0000	.0692	.0333	.1025
				TRow	.0000	.0188	.1121	.1309
				TOvl	.0000	.0000	.4746	.4746
15	.60	.65574	.74245	PLAN	.0000	.0000	.0195	.0195
				FISH	.0000	.0000	.0195	.0195
				KEP	.0000	.0188	.0079	.0267
				MB	.0000	.0427	.0048	.0475
				MBB	.0000	.0448	.0048	.0496
				BON	.0000	.0692	.0034	.0726
				TRow	.0000	.0188	.0268	.0456
				TOvl	.0000	.0000	.2530	.2530
15	.60	.65574	.79609	PLAN	.0000	.0000	.0073	.0073
				FISH	.0000	.0000	.0073	.0073
				KEP	.0000	.0166	.0009	.0175
				MB	.0000	.0401	.0006	.0407
				MBB	.0000	.0415	.0006	.0421
				BON	.0000	.0724	.0001	.0725
				TRow	.0000	.0166	.0066	.0232
				TOvl	.0000	.0000	.1802	.1802

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.60	.55678	.53032	PLAN	.0000	.0000	.1770	.1770
				FISH	.0000	.0000	.1770	.1770
				KEP	.0000	.0795	.1137	.1932
				MB	.0000	.1461	.0854	.2315
				MBB	.0000	.1514	.0832	.2346
				BON	.0000	.2116	.0654	.2770
				TRow	.0000	.0795	.2188	.2983
				TOvl	.0000	.0000	.6980	.6980
15	.60	.55678	.63639	PLAN	.0000	.0000	.0694	.0694
				FISH	.0000	.0000	.0694	.0694
				KEP	.0000	.0795	.0200	.0995
				MB	.0000	.1461	.0106	.1567
				MBB	.0000	.1514	.0102	.1616
				BON	.0000	.2116	.0069	.2185
				TRow	.0000	.0795	.0605	.1400
				TOvl	.0000	.0000	.4767	.4767
15	.60	.55678	.67361	PLAN	.0000	.0000	.0445	.0445
				FISH	.0000	.0000	.0445	.0445
				KEP	.0000	.0768	.0058	.0826
				MB	.0000	.1450	.0024	.1474
				MBB	.0000	.1507	.0024	.1531
				BON	.0000	.2076	.0014	.2090
				TRow	.0000	.0768	.0227	.0995
				TOvl	.0000	.0000	.3971	.3971
15	.60	.60000	.36742	PLAN	.0000	.0000	.4815	.4815
				FISH	.0000	.0000	.4815	.4815
				KEP	.0000	.0433	.4401	.4834
				MB	.0000	.0897	.4012	.4909
				MBB	.0000	.0940	.3979	.4919
				BON	.0000	.1363	.3661	.5024
				TRow	.0000	.0433	.5911	.6344
				TOvl	.0000	.0000	.9169	.9169
15	.60	.60000	.63639	PLAN	.0000	.0000	.0684	.0684
				FISH	.0000	.0000	.0684	.0684
				KEP	.0000	.0453	.0379	.0832
				MB	.0000	.0915	.0262	.1177
				MBB	.0000	.0958	.0254	.1212
				BON	.0000	.1406	.0188	.1594
				TRow	.0000	.0453	.0914	.1367
				TOvl	.0000	.0000	.4791	.4791
15	.60	.60000	.73485	PLAN	.0000	.0000	.0198	.0198
				FISH	.0000	.0000	.0198	.0198
				KEP	.0000	.0433	.0014	.0447
				MB	.0000	.0897	.0006	.0903
				MBB	.0000	.0940	.0006	.0946
				BON	.0000	.1363	.0003	.1366
				TRow	.0000	.0433	.0094	.0527
				TOvl	.0000	.0000	.2758	.2758

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.60	.52202	.52052	PLAN	.0000	.0000	.1908	.1908
				FISH	.0000	.0000	.1908	.1908
				KEP	.0000	.1161	.1006	.2167
				MB	.0000	.2027	.0690	.2717
				MBB	.0000	.2085	.0674	.2759
				BON	.0000	.2794	.0505	.3299
				TRow	.0000	.1161	.1980	.3141
				TOvl	.0000	.0000	.7169	.7169
15	.60	.52202	.58176	PLAN	.0000	.0000	.1149	.1149
				FISH	.0000	.0000	.1149	.1149
				KEP	.0000	.1161	.0375	.1536
				MB	.0000	.2027	.0205	.2232
				MBB	.0000	.2085	.0200	.2285
				BON	.0000	.2794	.0141	.2935
				TRow	.0000	.1161	.0959	.2120
				TOvl	.0000	.0000	.5930	.5930
15	.60	.52202	.63639	PLAN	.0000	.0000	.0646	.0646
				FISH	.0000	.0000	.0646	.0646
				KEP	.0000	.1117	.0052	.1169
				MB	.0000	.1967	.0019	.1986
				MBB	.0000	.2032	.0018	.2050
				BON	.0000	.2760	.0008	.2768
				TRow	.0000	.1117	.0250	.1367
				TOvl	.0000	.0000	.4754	.4754
15	.60	.55678	.10606	PLAN	.0000	.0000	.9078	.9078
				FISH	.0000	.0000	.9078	.9078
				KEP	.0000	.0795	.8288	.9083
				MB	.0000	.1461	.7637	.9098
				MBB	.0000	.1514	.7587	.9101
				BON	.0000	.2116	.7007	.9123
				TRow	.0000	.0795	.8793	.9588
				TOvl	.0000	.0000	.9976	.9976
15	.60	.55678	.24495	PLAN	.0000	.0000	.7360	.7360
				FISH	.0000	.0000	.7360	.7360
				KEP	.0000	.0768	.6605	.7373
				MB	.0000	.1450	.5969	.7419
				MBB	.0000	.1507	.5916	.7423
				BON	.0000	.2076	.5411	.7487
				TRow	.0000	.0768	.7705	.8473
				TOvl	.0000	.0000	.9792	.9792
15	.60	.55678	.42866	PLAN	.0000	.0000	.3519	.3519
				FISH	.0000	.0000	.3519	.3519
				KEP	.0000	.0768	.2827	.3595
				MB	.0000	.1450	.2360	.3810
				MBB	.0000	.1507	.2326	.3833
				BON	.0000	.2076	.2006	.4082
				TRow	.0000	.0768	.4300	.5068
				TOvl	.0000	.0000	.8549	.8549

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.65000	.39804	PLAN	.0000	.0000	.4189	.4189
				FISH	.0036	.0000	.4163	.4199
				KEP	.0036	.0194	.3976	.4206
				MB	.0036	.0474	.3735	.4245
				MBB	.0036	.0504	.3711	.4251
				BON	.0036	.0779	.3503	.4318
				TRow	.0036	.0194	.5510	.5740
				TOvl	.0036	.0000	.8851	.8887
15	.40	.65000	.68943	PLAN	.0000	.0000	.0337	.0337
				FISH	.0037	.0000	.0331	.0368
				KEP	.0037	.0196	.0197	.0430
				MB	.0037	.0437	.0141	.0615
				MBB	.0037	.0462	.0139	.0638
				BON	.0037	.0754	.0109	.0900
				TRow	.0037	.0196	.0585	.0818
				TOvl	.0037	.0000	.3650	.3687
15	.40	.65000	.79609	PLAN	.0000	.0000	.0076	.0076
				FISH	.0036	.0000	.0075	.0111
				KEP	.0036	.0194	.0004	.0234
				MB	.0036	.0474	.0000	.0510
				MBB	.0036	.0504	.0000	.0540
				BON	.0036	.0779	.0000	.0815
				TRow	.0036	.0194	.0047	.0277
				TOvl	.0036	.0000	.1750	.1786
15	.60	.52202	.06124	PLAN	.0000	.0000	.9340	.9340
				FISH	.0000	.0000	.9340	.9340
				KEP	.0000	.1161	.8185	.9346
				MB	.0000	.2027	.7335	.9362
				MBB	.0000	.2085	.7278	.9363
				BON	.0000	.2794	.6591	.9385
				TRow	.0000	.1161	.8563	.9724
				TOvl	.0000	.0000	.9988	.9988
15	.60	.52202	.26517	PLAN	.0000	.0000	.6977	.6977
				FISH	.0000	.0000	.6977	.6977
				KEP	.0000	.1117	.5885	.7002
				MB	.0000	.1967	.5132	.7099
				MBB	.0000	.2032	.5078	.7110
				BON	.0000	.2760	.4478	.7238
				TRow	.0000	.1117	.7105	.8222
				TOvl	.0000	.0000	.9733	.9733
15	.60	.52202	.37123	PLAN	.0000	.0000	.4694	.4694
				FISH	.0000	.0000	.4694	.4694
				KEP	.0000	.1117	.3653	.4770
				MB	.0000	.1967	.3026	.4993
				MBB	.0000	.2032	.2983	.5015
				BON	.0000	.2760	.2512	.5272
				TRow	.0000	.1117	.5144	.6261
				TOvl	.0000	.0000	.9170	.9170

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.56789	.09186	PLAN	.0000	.0000	.9231	.9231
				FISH	.0036	.0000	.9195	.9231
				KEP	.0036	.0661	.8537	.9234
				MB	.0036	.1274	.7931	.9241
				MBB	.0036	.1325	.7883	.9244
				BON	.0036	.1847	.7377	.9260
				TRow	.0036	.0661	.8959	.9656
				TOvl	.0036	.0000	.9952	.9988
15	.40	.56789	.26517	PLAN	.0000	.0000	.6967	.6967
				FISH	.0037	.0000	.6940	.6977
				KEP	.0037	.0632	.6317	.6986
				MB	.0037	.1251	.5753	.7041
				MBB	.0037	.1293	.5715	.7045
				BON	.0037	.1824	.5246	.7107
				TRow	.0037	.0632	.7467	.8136
				TOvl	.0037	.0000	.9684	.9721
15	.40	.56789	.42426	PLAN	.0000	.0000	.3607	.3607
				FISH	.0037	.0000	.3578	.3615
				KEP	.0037	.0632	.3000	.3669
				MB	.0037	.1251	.2536	.3824
				MBB	.0037	.1293	.2507	.3837
				BON	.0037	.1824	.2192	.4053
				TRow	.0037	.0632	.4475	.5144
				TOvl	.0037	.0000	.8613	.8650
15	.40	.56789	.55114	PLAN	.0000	.0000	.1456	.1456
				FISH	.0036	.0000	.1449	.1485
				KEP	.0036	.0661	.0934	.1631
				MB	.0036	.1274	.0685	.1995
				MBB	.0036	.1325	.0668	.2029
				BON	.0036	.1847	.0522	.2405
				TRow	.0036	.0661	.1869	.2566
				TOvl	.0036	.0000	.6494	.6530
15	.40	.56789	.64300	PLAN	.0000	.0000	.0629	.0629
				FISH	.0036	.0000	.0615	.0651
				KEP	.0036	.0661	.0212	.0909
				MB	.0036	.1274	.0134	.1444
				MBB	.0036	.1325	.0131	.1492
				BON	.0036	.1847	.0085	.1968
				TRow	.0036	.0661	.0615	.1312
				TOvl	.0036	.0000	.4571	.4607
15	.40	.56789	.68943	PLAN	.0000	.0000	.0320	.0320
				FISH	.0037	.0000	.0316	.0353
				KEP	.0037	.0632	.0041	.0710
				MB	.0037	.1251	.0020	.1308
				MBB	.0037	.1293	.0018	.1348
				BON	.0037	.1824	.0008	.1869
				TRow	.0037	.0632	.0192	.0861
				TOvl	.0037	.0000	.3558	.3595

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.45826	.42426	PLAN	.0000	.0000	.3584	.3584
				FISH	.0033	.0000	.3558	.3591
				KEP	.0033	.2067	.1817	.3917
				MB	.0033	.3234	.1229	.4496
				MBB	.0033	.3318	.1197	.4548
				BON	.0033	.4172	.0893	.5098
				TRow	.0033	.2067	.3022	.5122
				TOvl	.0033	.0000	.8533	.8566
15	.40	.45826	.53032	PLAN	.0000	.0000	.1649	.1649
				FISH	.0033	.0000	.1629	.1662
				KEP	.0033	.2067	.0304	.2404
				MB	.0033	.3234	.0142	.3409
				MBB	.0033	.3318	.0137	.3488
				BON	.0033	.4172	.0084	.4289
				TRow	.0033	.2067	.0831	.2931
				TOvl	.0033	.0000	.6858	.6891
15	.40	.45826	.55114	PLAN	.0000	.0000	.1541	.1541
				FISH	.0051	.0000	.1508	.1559
				KEP	.0051	.2178	.0160	.2389
				MB	.0051	.3392	.0070	.3513
				MBB	.0051	.3472	.0064	.3587
				BON	.0051	.4318	.0037	.4406
				TRow	.0051	.2178	.0528	.2757
				TOvl	.0051	.0000	.6445	.6496
15	.40	.50000	.30619	PLAN	.0000	.0000	.6080	.6080
				FISH	.0051	.0000	.6034	.6085
				KEP	.0051	.1375	.4726	.6152
				MB	.0051	.2342	.3937	.6330
				MBB	.0051	.2427	.3874	.6352
				BON	.0051	.3142	.3349	.6542
				TRow	.0051	.1375	.6023	.7449
				TOvl	.0051	.0000	.9531	.9582
15	.40	.50000	.53032	PLAN	.0000	.0000	.1739	.1739
				FISH	.0033	.0000	.1721	.1754
				KEP	.0033	.1434	.0691	.2158
				MB	.0033	.2439	.0421	.2893
				MBB	.0033	.2514	.0403	.2950
				BON	.0033	.3309	.0270	.3612
				TRow	.0033	.1434	.1548	.3015
				TOvl	.0033	.0000	.6987	.7020
15	.40	.50000	.61238	PLAN	.0000	.0000	.0847	.0847
				FISH	.0051	.0000	.0825	.0876
				KEP	.0051	.1375	.0067	.1493
				MB	.0051	.2342	.0026	.2419
				MBB	.0051	.2427	.0023	.2501
				BON	.0051	.3142	.0010	.3203
				TRow	.0051	.1375	.0285	.1711
				TOvl	.0051	.0000	.5216	.5267

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.40000	.24495	PLAN	.0000	.0000	.7335	.7335
				FISH	.0031	.0000	.7306	.7337
				KEP	.0031	.3333	.4117	.7481
				MB	.0031	.4759	.2980	.7770
				MBB	.0031	.4860	.2904	.7795
				BON	.0031	.5767	.2251	.8049
				TRow	.0031	.3333	.5086	.8450
				TOvl	.0031	.0000	.9778	.9809
15	.40	.40000	.42426	PLAN	.0000	.0000	.3640	.3640
				FISH	.0036	.0000	.3609	.3645
				KEP	.0036	.3355	.0938	.4329
				MB	.0036	.4799	.0508	.5343
				MBB	.0036	.4888	.0488	.5412
				BON	.0036	.5762	.0322	.6120
				TRow	.0036	.3355	.1834	.5225
				TOvl	.0036	.0000	.8574	.8610
15	.40	.40000	.48990	PLAN	.0000	.0000	.2355	.2355
				FISH	.0031	.0000	.2331	.2362
				KEP	.0031	.3333	.0136	.3500
				MB	.0031	.4759	.0046	.4836
				MBB	.0031	.4860	.0042	.4933
				BON	.0031	.5767	.0021	.5819
				TRow	.0031	.3333	.0506	.3870
				TOvl	.0031	.0000	.7640	.7671
15	.40	.45826	.10606	PLAN	.0000	.0000	.9079	.9079
				FISH	.0033	.0000	.9048	.9081
				KEP	.0033	.2067	.7005	.9105
				MB	.0033	.3234	.5886	.9153
				MBB	.0033	.3318	.5806	.9157
				BON	.0033	.4172	.5018	.9223
				TRow	.0033	.2067	.7503	.9603
				TOvl	.0033	.0000	.9944	.9977
15	.40	.45826	.18372	PLAN	.0000	.0000	.8267	.8267
				FISH	.0051	.0000	.8216	.8267
				KEP	.0051	.2178	.6081	.8310
				MB	.0051	.3392	.4965	.8408
				MBB	.0051	.3472	.4893	.8416
				BON	.0051	.4318	.4155	.8524
				TRow	.0051	.2178	.6866	.9095
				TOvl	.0051	.0000	.9862	.9913
15	.40	.45826	.36742	PLAN	.0000	.0000	.4835	.4835
				FISH	.0051	.0000	.4796	.4847
				KEP	.0051	.2178	.2834	.5063
				MB	.0051	.3392	.2068	.5511
				MBB	.0051	.3472	.2024	.5547
				BON	.0051	.4318	.1571	.5940
				TRow	.0051	.2178	.4132	.6361
				TOvl	.0051	.0000	.9159	.9210

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.36056	.10606	PLAN	.0000	.0000	.9145	.9145
				FISH	.0033	.0000	.9113	.9146
				KEP	.0033	.4316	.4858	.9207
				MB	.0033	.5776	.3499	.9308
				MBB	.0033	.5877	.3405	.9315
				BON	.0033	.6716	.2656	.9405
				TRow	.0033	.4316	.5273	.9622
				TOvl	.0033	.0000	.9941	.9974
15	.40	.36056	.12248	PLAN	.0000	.0000	.8954	.8954
				FISH	.0051	.0000	.8905	.8956
				KEP	.0051	.4244	.4731	.9026
				MB	.0051	.5753	.3350	.9154
				MBB	.0051	.5850	.3263	.9164
				BON	.0051	.6708	.2527	.9286
				TRow	.0051	.4244	.5217	.9512
				TOvl	.0051	.0000	.9918	.9969
15	.40	.36056	.30619	PLAN	.0000	.0000	.6144	.6144
				FISH	.0051	.0000	.6099	.6150
				KEP	.0051	.4244	.2268	.6563
				MB	.0051	.5753	.1403	.7207
				MBB	.0051	.5850	.1353	.7254
				BON	.0051	.6708	.0943	.7702
				TRow	.0051	.4244	.3263	.7558
				TOvl	.0051	.0000	.9518	.9569
15	.40	.36056	.31819	PLAN	.0000	.0000	.5842	.5842
				FISH	.0033	.0000	.5811	.5844
				KEP	.0033	.4316	.1957	.6306
				MB	.0033	.5776	.1191	.7000
				MBB	.0033	.5877	.1147	.7057
				BON	.0033	.6716	.0798	.7547
				TRow	.0033	.4316	.2971	.7320
				TOvl	.0033	.0000	.9477	.9510
15	.40	.36056	.42426	PLAN	.0000	.0000	.3646	.3646
				FISH	.0033	.0000	.3618	.3651
				KEP	.0033	.4316	.0378	.4727
				MB	.0033	.5776	.0162	.5971
				MBB	.0033	.5877	.0152	.6062
				BON	.0033	.6716	.0089	.6838
				TRow	.0033	.4316	.0918	.5267
				TOvl	.0033	.0000	.8590	.8623
15	.40	.36056	.42866	PLAN	.0000	.0000	.3514	.3514
				FISH	.0051	.0000	.3470	.3521
				KEP	.0051	.4244	.0337	.4632
				MB	.0051	.5753	.0137	.5941
				MBB	.0051	.5850	.0129	.6030
				BON	.0051	.6708	.0075	.6834
				TRow	.0051	.4244	.0845	.5140
				TOvl	.0051	.0000	.8504	.8555

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.40	.35000	.06124	PLAN	.0000	.0000	.9333	.9333
				FISH	.0036	.0000	.9299	.9335
				KEP	.0036	.4558	.4804	.9398
				MB	.0036	.6015	.3440	.9491
				MBB	.0036	.6106	.3357	.9499
				BON	.0036	.6900	.2625	.9561
				TRow	.0036	.4558	.5150	.9744
				TOvl	.0036	.0000	.9950	.9986
15	.40	.35000	.15910	PLAN	.0000	.0000	.8593	.8593
				FISH	.0037	.0000	.8556	.8593
				KEP	.0037	.4522	.4142	.8701
				MB	.0037	.5997	.2872	.8906
				MBB	.0037	.6093	.2794	.8924
				BON	.0037	.6939	.2115	.9091
				TRow	.0037	.4522	.4727	.9286
				TOvl	.0037	.0000	.9904	.9941
15	.40	.35000	.26517	PLAN	.0000	.0000	.6921	.6921
				FISH	.0037	.0000	.6893	.6930
				KEP	.0037	.4522	.2697	.7256
				MB	.0037	.5997	.1714	.7748
				MBB	.0037	.6093	.1659	.7789
				BON	.0037	.6939	.1179	.8155
				TRow	.0037	.4522	.3614	.8173
				TOvl	.0037	.0000	.9717	.9754
15	.40	.35000	.33681	PLAN	.0000	.0000	.5505	.5505
				FISH	.0036	.0000	.5470	.5506
				KEP	.0036	.4558	.1502	.6096
				MB	.0036	.6015	.0863	.6914
				MBB	.0036	.6106	.0827	.6969
				BON	.0036	.6900	.0567	.7503
				TRow	.0036	.4558	.2411	.7005
				TOvl	.0036	.0000	.9369	.9405
15	.40	.35000	.39804	PLAN	.0000	.0000	.4155	.4155
				FISH	.0036	.0000	.4128	.4164
				KEP	.0036	.4558	.0570	.5164
				MB	.0036	.6015	.0266	.6317
				MBB	.0036	.6106	.0248	.6390
				BON	.0036	.6900	.0144	.7080
				TRow	.0036	.4558	.1216	.5810
				TOvl	.0036	.0000	.8845	.8881
15	.40	.35000	.42426	PLAN	.0000	.0000	.3561	.3561
				FISH	.0037	.0000	.3530	.3567
				KEP	.0037	.4522	.0231	.4790
				MB	.0037	.5997	.0082	.6116
				MBB	.0037	.6093	.0077	.6207
				BON	.0037	.6939	.0038	.7014
				TRow	.0037	.4522	.0685	.5244
				TOvl	.0037	.0000	.8550	.8587

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
15	.25	.43302	.26517	PLAN	.0000	.0000	.6981	.6981
				FISH	.2463	.0000	.4994	.7457
				KEP	.2463	.1626	.3438	.7527
				MB	.2463	.2524	.2718	.7705
				MBB	.2463	.2581	.2674	.7718
				BON	.2463	.3264	.2192	.7919
				TRow	.2463	.1626	.4324	.8413
				TOvl	.2463	.0000	.7293	.9756
15	.25	.43302	.45928	PLAN	.0000	.0000	.2896	.2896
				FISH	.2475	.0000	.1865	.4340
				KEP	.2475	.1595	.0660	.4730
				MB	.2475	.2490	.0396	.5361
				MBB	.2475	.2555	.0385	.5415
				BON	.2475	.3184	.0270	.5929
				TRow	.2475	.1595	.1323	.5393
				TOvl	.2475	.0000	.5809	.8284
15	.25	.43302	.53032	PLAN	.0000	.0000	.1754	.1754
				FISH	.2463	.0000	.1082	.3545
				KEP	.2463	.1626	.0078	.4167
				MB	.2463	.2524	.0023	.5010
				MBB	.2463	.2581	.0023	.5067
				BON	.2463	.3264	.0008	.5735
				TRow	.2463	.1626	.0307	.4396
				TOvl	.2463	.0000	.4791	.7254
15	.25	.50000	.30619	PLAN	.0000	.0000	.6152	.6152
				FISH	.2475	.0000	.4332	.6807
				KEP	.2475	.0840	.3534	.6849
				MB	.2475	.1405	.3069	.6949
				MBB	.2475	.1451	.3035	.6961
				BON	.2475	.1905	.2697	.7077
				TRow	.2475	.0840	.4519	.7834
				TOvl	.2475	.0000	.7114	.9589
15	.25	.50000	.53032	PLAN	.0000	.0000	.1756	.1756
				FISH	.2463	.0000	.1070	.3533
				KEP	.2463	.0811	.0481	.3755
				MB	.2463	.1432	.0308	.4203
				MBB	.2463	.1474	.0298	.4235
				BON	.2463	.1988	.0217	.4668
				TRow	.2463	.0811	.1044	.4318
				TOvl	.2463	.0000	.4868	.7331
15	.25	.50000	.61238	PLAN	.0000	.0000	.0884	.0884
				FISH	.2475	.0000	.0502	.2977
				KEP	.2475	.0840	.0041	.3356
				MB	.2475	.1405	.0012	.3892
				MBB	.2475	.1451	.0012	.3938
				BON	.2475	.1905	.0005	.4385
				TRow	.2475	.0840	.0168	.3483
				TOvl	.2475	.0000	.3352	.5827

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.25	.31225	.27556	PLAN	.0000	.0000	.6696	.6696
				FISH	.2514	.0000	.4696	.7210
				KEP	.2514	.3604	.1458	.7576
				MB	.2514	.4692	.0874	.8080
				MBB	.2514	.4770	.0838	.8122
				BON	.2514	.5396	.0580	.8490
				TRow	.2514	.3604	.2150	.8268
				TOvl	.2514	.0000	.7199	.9713
15	.25	.31225	.36742	PLAN	.0000	.0000	.4815	.4815
				FISH	.2514	.0000	.3069	.5583
				KEP	.2514	.3604	.0318	.6436
				MB	.2514	.4692	.0152	.7358
				MBB	.2514	.4770	.0144	.7428
				BON	.2514	.5396	.0084	.7994
				TRow	.2514	.3604	.0703	.6821
				TOvl	.2514	.0000	.6684	.9198
15	.25	.31225	.37123	PLAN	.0000	.0000	.4695	.4695
				FISH	.2446	.0000	.3120	.5566
				KEP	.2446	.3674	.0305	.6425
				MB	.2446	.4765	.0141	.7352
				MBB	.2446	.4847	.0135	.7428
				BON	.2446	.5433	.0082	.7961
				TRow	.2446	.3674	.0729	.6849
				TOvl	.2446	.0000	.6734	.9180
15	.25	.35000	.21433	PLAN	.0000	.0000	.7813	.7813
				FISH	.2514	.0000	.5578	.8092
				KEP	.2514	.2828	.2899	.8241
				MB	.2514	.3946	.2038	.8498
				MBB	.2514	.4024	.1983	.8521
				BON	.2514	.4663	.1539	.8716
				TRow	.2514	.2828	.3571	.8913
				TOvl	.2514	.0000	.7367	.9881
15	.25	.35000	.37123	PLAN	.0000	.0000	.4698	.4698
				FISH	.2446	.0000	.3044	.5490
				KEP	.2446	.2815	.0779	.6040
				MB	.2446	.3928	.0431	.6805
				MBB	.2446	.3998	.0415	.6859
				BON	.2446	.4684	.0268	.7398
				TRow	.2446	.2815	.1440	.6701
				TOvl	.2446	.0000	.6729	.9175
15	.25	.35000	.42866	PLAN	.0000	.0000	.3474	.3474
				FISH	.2514	.0000	.2088	.4602
				KEP	.2514	.2828	.0144	.5486
				MB	.2514	.3946	.0057	.6517
				MBB	.2514	.4024	.0051	.6589
				BON	.2514	.4663	.0023	.7200
				TRow	.2514	.2828	.0457	.5799
				TOvl	.2514	.0000	.6050	.8564

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.25	.25000	.15309	PLAN	.0000	.0000	.8680	.8680
				FISH	.2555	.0000	.6257	.8812
				KEP	.2555	.4718	.1757	.9030
				MB	.2555	.5696	.1031	.9282
				MBB	.2555	.5753	.0992	.9300
				BON	.2555	.6247	.0663	.9465
				TRow	.2555	.4718	.2118	.9391
				TOvl	.2555	.0000	.7390	.9945
15	.25	.25000	.26517	PLAN	.0000	.0000	.6963	.6963
				FISH	.2572	.0000	.4714	.7286
				KEP	.2572	.4672	.0662	.7906
				MB	.2572	.5668	.0315	.8555
				MBB	.2572	.5726	.0298	.8596
				BON	.2572	.6208	.0177	.8957
				TRow	.2572	.4672	.1105	.8349
				TOvl	.2572	.0000	.7163	.9735
15	.25	.25000	.30619	PLAN	.0000	.0000	.6174	.6174
				FISH	.2555	.0000	.4055	.6610
				KEP	.2555	.4718	.0242	.7515
				MB	.2555	.5696	.0086	.8337
				MBB	.2555	.5753	.0080	.8388
				BON	.2555	.6247	.0040	.8842
				TRow	.2555	.4718	.0547	.7820
				TOvl	.2555	.0000	.7025	.9580
15	.25	.31225	.09186	PLAN	.0000	.0000	.9202	.9202
				FISH	.2514	.0000	.6752	.9266
				KEP	.2514	.3604	.3234	.9352
				MB	.2514	.4692	.2249	.9455
				MBB	.2514	.4770	.2180	.9464
				BON	.2514	.5396	.1632	.9542
				TRow	.2514	.3604	.3579	.9697
				TOvl	.2514	.0000	.7465	.9979
15	.25	.31225	.10606	PLAN	.0000	.0000	.9106	.9106
				FISH	.2446	.0000	.6796	.9242
				KEP	.2446	.3674	.3189	.9309
				MB	.2446	.4765	.2207	.9418
				MBB	.2446	.4847	.2137	.9430
				BON	.2446	.5433	.1638	.9517
				TRow	.2446	.3674	.3536	.9656
				TOvl	.2446	.0000	.7539	.9985
15	.25	.31225	.26517	PLAN	.0000	.0000	.6974	.6974
				FISH	.2446	.0000	.4885	.7331
				KEP	.2446	.3674	.1569	.7689
				MB	.2446	.4765	.0985	.8196
				MBB	.2446	.4847	.0944	.8237
				BON	.2446	.5433	.0668	.8547
				TRow	.2446	.3674	.2241	.8361
				TOvl	.2446	.0000	.7299	.9745

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
15	.25	.21795	.03062	PLAN	.0000	.0000	.9511	.9511
				FISH	.2514	.0000	.7043	.9557
				KEP	.2514	.5363	.1785	.9662
				MB	.2514	.6221	.1028	.9763
				MBB	.2514	.6264	.0990	.9768
				BON	.2514	.6658	.0661	.9833
				TRow	.2514	.5363	.1953	.9830
				TOvl	.2514	.0000	.7480	.9994
15	.25	.21795	.10606	PLAN	.0000	.0000	.9105	.9105
				FISH	.2446	.0000	.6798	.9244
				KEP	.2446	.5374	.1590	.9410
				MB	.2446	.6233	.0902	.9581
				MBB	.2446	.6290	.0857	.9593
				BON	.2446	.6690	.0565	.9701
				TRow	.2446	.5374	.1843	.9663
				TOvl	.2446	.0000	.7534	.9980
15	.25	.21795	.15910	PLAN	.0000	.0000	.8587	.8587
				FISH	.2446	.0000	.6221	.8667
				KEP	.2446	.5374	.1173	.8993
				MB	.2446	.6233	.0632	.9311
				MBB	.2446	.6290	.0600	.9336
				BON	.2446	.6690	.0390	.9526
				TRow	.2446	.5374	.1508	.9328
				TOvl	.2446	.0000	.7501	.9947
15	.25	.21795	.21433	PLAN	.0000	.0000	.7855	.7855
				FISH	.2514	.0000	.5608	.8122
				KEP	.2514	.5363	.0735	.8612
				MB	.2514	.6221	.0350	.9085
				MBB	.2514	.6264	.0333	.9111
				BON	.2514	.6658	.0186	.9358
				TRow	.2514	.5363	.1090	.8967
				TOvl	.2514	.0000	.7359	.9873
15	.25	.21795	.24495	PLAN	.0000	.0000	.7354	.7354
				FISH	.2514	.0000	.5050	.7564
				KEP	.2514	.5363	.0428	.8305
				MB	.2514	.6221	.0182	.8917
				MBB	.2514	.6264	.0175	.8953
				BON	.2514	.6658	.0095	.9267
				TRow	.2514	.5363	.0753	.8630
				TOvl	.2514	.0000	.7300	.9814
15	.25	.21795	.26517	PLAN	.0000	.0000	.6930	.6930
				FISH	.2446	.0000	.4813	.7259
				KEP	.2446	.5374	.0262	.8082
				MB	.2446	.6233	.0096	.8775
				MBB	.2446	.6290	.0088	.8824
				BON	.2446	.6690	.0048	.9184
				TRow	.2446	.5374	.0533	.8353
				TOvl	.2446	.0000	.7301	.9747

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.60	.75664	.67361	PLAN	.0000	.0000	.2398	.2398
				FISH	.0015	.0000	.2388	.2403
				KEP	.0015	.0878	.1647	.2540
				MB	.0015	.1553	.1286	.2854
				MBB	.0015	.1635	.1247	.2897
				BON	.0015	.2248	.1008	.3271
				TRow	.0015	.0878	.2911	.3804
				TOvl	.0015	.0000	.7728	.7743
8	.60	.75664	.88795	PLAN	.0000	.0000	.0627	.0627
				FISH	.0015	.0000	.0620	.0635
				KEP	.0015	.0878	.0127	.1020
				MB	.0015	.1553	.0055	.1623
				MBB	.0015	.1635	.0051	.1701
				BON	.0015	.2248	.0037	.2300
				TRow	.0015	.0878	.0432	.1325
				TOvl	.0015	.0000	.4699	.4714
8	.60	.75664	.90156	PLAN	.0000	.0000	.0549	.0549
				FISH	.0007	.0000	.0547	.0554
				KEP	.0007	.0892	.0095	.0994
				MB	.0007	.1636	.0045	.1688
				MBB	.0007	.1703	.0041	.1751
				BON	.0007	.2362	.0026	.2395
				TRow	.0007	.0892	.0337	.1236
				TOvl	.0007	.0000	.4526	.4533
8	.60	.85001	.52052	PLAN	.0000	.0000	.4626	.4626
				FISH	.0015	.0000	.4614	.4629
				KEP	.0015	.0361	.4269	.4645
				MB	.0015	.0759	.3928	.4702
				MBB	.0015	.0793	.3900	.4708
				BON	.0015	.1187	.3615	.4817
				TRow	.0015	.0361	.5745	.6121
				TOvl	.0015	.0000	.9110	.9125
8	.60	.85001	.90156	PLAN	.0000	.0000	.0530	.0530
				FISH	.0007	.0000	.0529	.0536
				KEP	.0007	.0348	.0302	.0657
				MB	.0007	.0736	.0211	.0954
				MBB	.0007	.0774	.0205	.0986
				BON	.0007	.1162	.0152	.1321
				TRow	.0007	.0348	.0772	.1127
				TOvl	.0007	.0000	.4471	.4478
8	.60	.85001	1.04100	PLAN	.0000	.0000	.0165	.0165
				FISH	.0015	.0000	.0162	.0177
				KEP	.0015	.0361	.0012	.0388
				MB	.0015	.0759	.0005	.0779
				MBB	.0015	.0793	.0005	.0813
				BON	.0015	.1187	.0001	.1203
				TRow	.0015	.0361	.0084	.0460
				TOvl	.0015	.0000	.2488	.2503

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.60	.70000	.42866	PLAN	.0000	.0000	.5973	.5973
				FISH	.0008	.0000	.5967	.5975
				KEP	.0008	.1303	.4714	.6025
				MB	.0008	.2266	.3935	.6209
				MBB	.0008	.2333	.3884	.6225
				BON	.0008	.3085	.3329	.6422
				TRow	.0008	.1303	.6104	.7415
				TOvl	.0008	.0000	.9560	.9568
8	.60	.70000	.74245	PLAN	.0000	.0000	.1584	.1584
				FISH	.0007	.0000	.1581	.1588
				KEP	.0007	.1306	.0652	.1965
				MB	.0007	.2301	.0398	.2706
				MBB	.0007	.2375	.0385	.2767
				BON	.0007	.3151	.0271	.3429
				TRow	.0007	.1306	.1502	.2815
				TOvl	.0007	.0000	.6908	.6915
8	.60	.70000	.85732	PLAN	.0000	.0000	.0783	.0783
				FISH	.0008	.0000	.0780	.0788
				KEP	.0008	.1303	.0068	.1379
				MB	.0008	.2266	.0029	.2303
				MBB	.0008	.2333	.0025	.2366
				BON	.0008	.3085	.0013	.3106
				TRow	.0008	.1303	.0286	.1597
				TOvl	.0008	.0000	.5118	.5126
8	.60	.75664	.21433	PLAN	.0000	.0000	.8604	.8604
				FISH	.0015	.0000	.8589	.8604
				KEP	.0015	.0878	.7718	.8611
				MB	.0015	.1553	.7074	.8642
				MBB	.0015	.1635	.6993	.8643
				BON	.0015	.2248	.6409	.8672
				TRow	.0015	.0878	.8431	.9324
				TOvl	.0015	.0000	.9941	.9956
8	.60	.75664	.26517	PLAN	.0000	.0000	.8191	.8191
				FISH	.0007	.0000	.8185	.8192
				KEP	.0007	.0892	.7298	.8197
				MB	.0007	.1636	.6591	.8234
				MBB	.0007	.1703	.6527	.8237
				BON	.0007	.2362	.5930	.8299
				TRow	.0007	.0892	.8158	.9057
				TOvl	.0007	.0000	.9912	.9919
8	.60	.75664	.63639	PLAN	.0000	.0000	.2908	.2908
				FISH	.0007	.0000	.2901	.2908
				KEP	.0007	.0892	.2112	.3011
				MB	.0007	.1636	.1662	.3305
				MBB	.0007	.1703	.1626	.3336
				BON	.0007	.2362	.1316	.3685
				TRow	.0007	.0892	.3517	.4416
				TOvl	.0007	.0000	.8174	.8181

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.60	.65574	.10606	PLAN	.0000	.0000	.9274	.9274
				FISH	.0007	.0000	.9267	.9274
				KEP	.0007	.1856	.7424	.9287
				MB	.0007	.3047	.6264	.9318
				MBB	.0007	.3133	.6180	.9320
				BON	.0007	.3947	.5416	.9370
				TRow	.0007	.1856	.7820	.9683
				TOvl	.0007	.0000	.9977	.9984
8	.60	.65574	.30619	PLAN	.0000	.0000	.7720	.7720
				FISH	.0008	.0000	.7712	.7720
				KEP	.0008	.1771	.5976	.7755
				MB	.0008	.2954	.4919	.7881
				MBB	.0008	.3036	.4844	.7888
				BON	.0008	.3941	.4089	.8038
				TRow	.0008	.1771	.6952	.8731
				TOvl	.0008	.0000	.9852	.9860
8	.60	.65574	.48990	PLAN	.0000	.0000	.5049	.5049
				FISH	.0008	.0000	.5043	.5051
				KEP	.0008	.1771	.3429	.5208
				MB	.0008	.2954	.2621	.5583
				MBB	.0008	.3036	.2572	.5616
				BON	.0008	.3941	.2030	.5979
				TRow	.0008	.1771	.4869	.6648
				TOvl	.0008	.0000	.9287	.9295
8	.60	.65574	.63639	PLAN	.0000	.0000	.2878	.2878
				FISH	.0007	.0000	.2872	.2879
				KEP	.0007	.1856	.1374	.3237
				MB	.0007	.3047	.0902	.3956
				MBB	.0007	.3133	.0881	.4021
				BON	.0007	.3947	.0640	.4594
				TRow	.0007	.1856	.2535	.4398
				TOvl	.0007	.0000	.8123	.8130
8	.60	.65574	.74245	PLAN	.0000	.0000	.1653	.1653
				FISH	.0007	.0000	.1650	.1657
				KEP	.0007	.1856	.0409	.2272
				MB	.0007	.3047	.0197	.3251
				MBB	.0007	.3133	.0185	.3325
				BON	.0007	.3947	.0119	.4073
				TRow	.0007	.1856	.1039	.2902
				TOvl	.0007	.0000	.6879	.6886
8	.60	.65574	.79609	PLAN	.0000	.0000	.1144	.1144
				FISH	.0008	.0000	.1139	.1147
				KEP	.0008	.1771	.0121	.1900
				MB	.0008	.2954	.0041	.3003
				MBB	.0008	.3036	.0038	.3082
				BON	.0008	.3941	.0021	.3970
				TRow	.0008	.1771	.0440	.2219
				TOvl	.0008	.0000	.6147	.6155

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.60	.55678	.53032	PLAN	.0000	.0000	.4386	.4386
				FISH	.0007	.0000	.4379	.4386
				KEP	.0007	.3267	.1604	.4878
				MB	.0007	.4709	.0981	.5697
				MBB	.0007	.4821	.0938	.5766
				BON	.0007	.5751	.0638	.6396
				TRow	.0007	.3267	.2719	.5993
				TOvl	.0007	.0000	.9050	.9057
8	.60	.55678	.63639	PLAN	.0000	.0000	.2867	.2867
				FISH	.0007	.0000	.2861	.2868
				KEP	.0007	.3267	.0482	.3756
				MB	.0007	.4709	.0222	.4938
				MBB	.0007	.4821	.0209	.5037
				BON	.0007	.5751	.0119	.5877
				TRow	.0007	.3267	.1162	.4436
				TOvl	.0007	.0000	.8139	.8146
8	.60	.55678	.67361	PLAN	.0000	.0000	.2371	.2371
				FISH	.0008	.0000	.2365	.2373
				KEP	.0008	.3285	.0182	.3475
				MB	.0008	.4743	.0066	.4817
				MBB	.0008	.4825	.0061	.4894
				BON	.0008	.5737	.0030	.5775
				TRow	.0008	.3285	.0592	.3885
				TOvl	.0008	.0000	.7743	.7751
8	.60	.60000	.36742	PLAN	.0000	.0000	.6929	.6929
				FISH	.0010	.0000	.6919	.6929
				KEP	.0010	.2606	.4430	.7046
				MB	.0010	.3922	.3373	.7305
				MBB	.0010	.4018	.3301	.7329
				BON	.0010	.4950	.2629	.7589
				TRow	.0010	.2606	.5529	.8145
				TOvl	.0010	.0000	.9735	.9745
8	.60	.60000	.63639	PLAN	.0000	.0000	.2857	.2857
				FISH	.0006	.0000	.2852	.2858
				KEP	.0006	.2589	.0859	.3454
				MB	.0006	.3909	.0485	.4400
				MBB	.0006	.3998	.0465	.4469
				BON	.0006	.4930	.0304	.5240
				TRow	.0006	.2589	.1785	.4380
				TOvl	.0006	.0000	.8164	.8170
8	.60	.60000	.73485	PLAN	.0000	.0000	.1714	.1714
				FISH	.0010	.0000	.1707	.1717
				KEP	.0010	.2606	.0106	.2722
				MB	.0010	.3922	.0034	.3966
				MBB	.0010	.4018	.0031	.4059
				BON	.0010	.4950	.0013	.4973
				TRow	.0010	.2606	.0425	.3041
				TOvl	.0010	.0000	.6998	.7008

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.60	.52202	.52052	PLAN	.0000	.0000	.4568	.4568
				FISH	.0015	.0000	.4555	.4570
				KEP	.0015	.3834	.1335	.5184
				MB	.0015	.5345	.0744	.6104
				MBB	.0015	.5448	.0712	.6175
				BON	.0015	.6323	.0478	.6816
				TRow	.0015	.3834	.2331	.6180
				TOvl	.0015	.0000	.9077	.9092
8	.60	.52202	.58176	PLAN	.0000	.0000	.3615	.3615
				FISH	.0015	.0000	.3601	.3616
				KEP	.0015	.3834	.0642	.4491
				MB	.0015	.5345	.0309	.5669
				MBB	.0015	.5448	.0295	.5758
				BON	.0015	.6323	.0181	.6519
				TRow	.0015	.3834	.1422	.5271
				TOvl	.0015	.0000	.8659	.8674
8	.60	.52202	.63639	PLAN	.0000	.0000	.2895	.2895
				FISH	.0007	.0000	.2889	.2896
				KEP	.0007	.3888	.0185	.4080
				MB	.0007	.5383	.0063	.5453
				MBB	.0007	.5479	.0059	.5545
				BON	.0007	.6387	.0028	.6422
				TRow	.0007	.3888	.0598	.4493
				TOvl	.0007	.0000	.8179	.8186
8	.60	.55678	.10606	PLAN	.0000	.0000	.9297	.9297
				FISH	.0007	.0000	.9290	.9297
				KEP	.0007	.3267	.6048	.9322
				MB	.0007	.4709	.4675	.9391
				MBB	.0007	.4821	.4571	.9399
				BON	.0007	.5751	.3705	.9463
				TRow	.0007	.3267	.6439	.9713
				TOvl	.0007	.0000	.9979	.9986
8	.60	.55678	.24495	PLAN	.0000	.0000	.8396	.8396
				FISH	.0008	.0000	.8389	.8397
				KEP	.0008	.3285	.5176	.8469
				MB	.0008	.4743	.3871	.8622
				MBB	.0008	.4825	.3799	.8632
				BON	.0008	.5737	.3018	.8763
				TRow	.0008	.3285	.5882	.9175
				TOvl	.0008	.0000	.9920	.9928
8	.60	.55678	.42866	PLAN	.0000	.0000	.6007	.6007
				FISH	.0008	.0000	.6000	.6008
				KEP	.0008	.3285	.2982	.6275
				MB	.0008	.4743	.2009	.6760
				MBB	.0008	.4825	.1967	.6800
				BON	.0008	.5737	.1479	.7224
				TRow	.0008	.3285	.4166	.7459
				TOvl	.0008	.0000	.9542	.9550

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.40	.65000	.39804	PLAN	.0000	.0000	.6472	.6472
				FISH	.1263	.0000	.5448	.6711
				KEP	.1263	.1387	.4137	.6787
				MB	.1263	.2339	.3365	.6967
				MBB	.1263	.2400	.3318	.6981
				BON	.1263	.3113	.2803	.7179
				TRow	.1263	.1387	.5240	.7890
				TOvl	.1263	.0000	.8389	.9652
8	.40	.65000	.68943	PLAN	.0000	.0000	.2237	.2237
				FISH	.1268	.0000	.1715	.2983
				KEP	.1268	.1447	.0657	.3372
				MB	.1268	.2357	.0401	.4026
				MBB	.1268	.2426	.0384	.4078
				BON	.1268	.3119	.0267	.4654
				TRow	.1268	.1447	.1384	.4099
				TOvl	.1268	.0000	.6395	.7663
8	.40	.65000	.79609	PLAN	.0000	.0000	.1190	.1190
				FISH	.1263	.0000	.0832	.2095
				KEP	.1263	.1387	.0057	.2707
				MB	.1263	.2339	.0024	.3626
				MBB	.1263	.2400	.0024	.3687
				BON	.1263	.3113	.0009	.4385
				TRow	.1263	.1387	.0272	.2922
				TOvl	.1263	.0000	.4924	.6187
8	.60	.52202	.06124	PLAN	.0000	.0000	.9425	.9425
				FISH	.0015	.0000	.9411	.9426
				KEP	.0015	.3834	.5612	.9461
				MB	.0015	.5345	.4161	.9521
				MBB	.0015	.5448	.4062	.9525
				BON	.0015	.6323	.3239	.9577
				TRow	.0015	.3834	.5913	.9762
				TOvl	.0015	.0000	.9975	.9990
8	.60	.52202	.26517	PLAN	.0000	.0000	.8164	.8164
				FISH	.0007	.0000	.8158	.8165
				KEP	.0007	.3888	.4384	.8279
				MB	.0007	.5383	.3116	.8506
				MBB	.0007	.5479	.3040	.8526
				BON	.0007	.6387	.2318	.8712
				TRow	.0007	.3888	.5125	.9020
				TOvl	.0007	.0000	.9892	.9899
8	.60	.52202	.37123	PLAN	.0000	.0000	.6895	.6895
				FISH	.0007	.0000	.6888	.6895
				KEP	.0007	.3888	.3236	.7131
				MB	.0007	.5383	.2171	.7561
				MBB	.0007	.5479	.2106	.7592
				BON	.0007	.6387	.1542	.7936
				TRow	.0007	.3888	.4242	.8137
				TOvl	.0007	.0000	.9738	.9745

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.40	.56789	.09186	PLAN	.0000	.0000	.9375	.9375
				FISH	.1263	.0000	.8132	.9395
				KEP	.1263	.2458	.5696	.9417
				MB	.1263	.3676	.4535	.9474
				MBB	.1263	.3758	.4459	.9480
				BON	.1263	.4576	.3678	.9517
				TRow	.1263	.2458	.6024	.9745
				TOvl	.1263	.0000	.8724	.9987
8	.40	.56789	.26517	PLAN	.0000	.0000	.8129	.8129
				FISH	.1268	.0000	.7031	.8299
				KEP	.1268	.2378	.4723	.8369
				MB	.1268	.3573	.3668	.8509
				MBB	.1268	.3650	.3599	.8517
				BON	.1268	.4444	.2932	.8644
				TRow	.1268	.2378	.5406	.9052
				TOvl	.1268	.0000	.8624	.9892
8	.40	.56789	.42426	PLAN	.0000	.0000	.6134	.6134
				FISH	.1268	.0000	.5042	.6310
				KEP	.1268	.2378	.2853	.6499
				MB	.1268	.3573	.2057	.6898
				MBB	.1268	.3650	.2011	.6929
				BON	.1268	.4444	.1565	.7277
				TRow	.1268	.2378	.3895	.7541
				TOvl	.1268	.0000	.8308	.9576
8	.40	.56789	.55114	PLAN	.0000	.0000	.4186	.4186
				FISH	.1263	.0000	.3453	.4716
				KEP	.1263	.2458	.1393	.5114
				MB	.1263	.3676	.0844	.5783
				MBB	.1263	.3758	.0814	.5835
				BON	.1263	.4576	.0572	.6411
				TRow	.1263	.2458	.2348	.6069
				TOvl	.1263	.0000	.7663	.8926
8	.40	.56789	.64300	PLAN	.0000	.0000	.2887	.2887
				FISH	.1263	.0000	.2184	.3447
				KEP	.1263	.2458	.0452	.4173
				MB	.1263	.3676	.0233	.5172
				MBB	.1263	.3758	.0220	.5241
				BON	.1263	.4576	.0137	.5976
				TRow	.1263	.2458	.1057	.4778
				TOvl	.1263	.0000	.6897	.8160
8	.40	.56789	.68943	PLAN	.0000	.0000	.2193	.2193
				FISH	.1268	.0000	.1687	.2955
				KEP	.1268	.2378	.0152	.3798
				MB	.1268	.3573	.0067	.4908
				MBB	.1268	.3650	.0062	.4980
				BON	.1268	.4444	.0032	.5744
				TRow	.1268	.2378	.0501	.4147
				TOvl	.1268	.0000	.6373	.7641

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.40	.45826	.42426	PLAN	.0000	.0000	.6170	.6170
				FISH	.1305	.0000	.5067	.6372
				KEP	.1305	.4071	.1496	.6872
				MB	.1305	.5345	.0880	.7530
				MBB	.1305	.5436	.0842	.7583
				BON	.1305	.6163	.0576	.8044
				TRow	.1305	.4071	.2288	.7664
				TOvl	.1305	.0000	.8304	.9609
8	.40	.45826	.53032	PLAN	.0000	.0000	.4445	.4445
				FISH	.1305	.0000	.3544	.4849
				KEP	.1305	.4071	.0400	.5776
				MB	.1305	.5345	.0180	.6830
				MBB	.1305	.5436	.0171	.6912
				BON	.1305	.6163	.0099	.7567
				TRow	.1305	.4071	.0910	.6286
				TOvl	.1305	.0000	.7723	.9028
8	.40	.45826	.55114	PLAN	.0000	.0000	.4101	.4101
				FISH	.1233	.0000	.3217	.4450
				KEP	.1233	.4013	.0241	.5487
				MB	.1233	.5373	.0096	.6702
				MBB	.1233	.5456	.0091	.6780
				BON	.1233	.6250	.0052	.7535
				TRow	.1233	.4013	.0686	.5932
				TOvl	.1233	.0000	.7709	.8942
8	.40	.50000	.30619	PLAN	.0000	.0000	.7703	.7703
				FISH	.1233	.0000	.6584	.7817
				KEP	.1233	.3338	.3402	.7973
				MB	.1233	.4595	.2398	.8226
				MBB	.1233	.4661	.2346	.8240
				BON	.1233	.5457	.1797	.8487
				TRow	.1233	.3338	.4181	.8752
				TOvl	.1233	.0000	.8618	.9851
8	.40	.50000	.53032	PLAN	.0000	.0000	.4412	.4412
				FISH	.1305	.0000	.3494	.4799
				KEP	.1305	.3300	.0874	.5479
				MB	.1305	.4649	.0465	.6419
				MBB	.1305	.4737	.0446	.6488
				BON	.1305	.5557	.0297	.7159
				TRow	.1305	.3300	.1680	.6285
				TOvl	.1305	.0000	.7769	.9074
8	.40	.50000	.61238	PLAN	.0000	.0000	.3128	.3128
				FISH	.1233	.0000	.2396	.3629
				KEP	.1233	.3338	.0140	.4711
				MB	.1233	.4595	.0047	.5875
				MBB	.1233	.4661	.0044	.5938
				BON	.1233	.5457	.0021	.6711
				TRow	.1233	.3338	.0470	.5041
				TOvl	.1233	.0000	.7076	.8309

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.40	.40000	.24495	PLAN	.0000	.0000	.8367	.8367
				FISH	.1288	.0000	.7145	.8433
				KEP	.1288	.4951	.2427	.8666
				MB	.1288	.6197	.1488	.8973
				MBB	.1288	.6271	.1436	.8995
				BON	.1288	.6917	.0988	.9193
				TRow	.1288	.4951	.2962	.9201
				TOvl	.1288	.0000	.8636	.9924
8	.40	.40000	.42426	PLAN	.0000	.0000	.6104	.6104
				FISH	.1245	.0000	.5032	.6277
				KEP	.1245	.4984	.0817	.7046
				MB	.1245	.6246	.0395	.7886
				MBB	.1245	.6318	.0375	.7938
				BON	.1245	.6960	.0228	.8433
				TRow	.1245	.4984	.1405	.7634
				TOvl	.1245	.0000	.8341	.9586
8	.40	.40000	.48990	PLAN	.0000	.0000	.5077	.5077
				FISH	.1288	.0000	.4032	.5320
				KEP	.1288	.4951	.0220	.6459
				MB	.1288	.6197	.0072	.7557
				MBB	.1288	.6271	.0066	.7625
				BON	.1288	.6917	.0033	.8238
				TRow	.1288	.4951	.0581	.6820
				TOvl	.1288	.0000	.8024	.9312
8	.40	.45826	.10606	PLAN	.0000	.0000	.9289	.9289
				FISH	.1305	.0000	.8023	.9328
				KEP	.1305	.4071	.4009	.9385
				MB	.1305	.5345	.2823	.9473
				MBB	.1305	.5436	.2739	.9480
				BON	.1305	.6163	.2096	.9564
				TRow	.1305	.4071	.4341	.9717
				TOvl	.1305	.0000	.8682	.9987
8	.40	.45826	.18372	PLAN	.0000	.0000	.8878	.8878
				FISH	.1233	.0000	.7675	.8908
				KEP	.1233	.4013	.3769	.9015
				MB	.1233	.5373	.2560	.9166
				MBB	.1233	.5456	.2486	.9175
				BON	.1233	.6250	.1823	.9306
				TRow	.1233	.4013	.4221	.9467
				TOvl	.1233	.0000	.8716	.9949
8	.40	.45826	.36742	PLAN	.0000	.0000	.6974	.6974
				FISH	.1233	.0000	.5926	.7159
				KEP	.1233	.4013	.2226	.7472
				MB	.1233	.5373	.1374	.7980
				MBB	.1233	.5456	.1320	.8009
				BON	.1233	.6250	.0892	.8375
				TRow	.1233	.4013	.2985	.8231
				TOvl	.1233	.0000	.8513	.9746

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.40	.36056	.10606	PLAN	.0000	.0000	.9322	.9322
				FISH	.1305	.0000	.8056	.9361
				KEP	.1305	.5542	.2614	.9461
				MB	.1305	.6704	.1590	.9599
				MBB	.1305	.6778	.1528	.9611
				BON	.1305	.7336	.1060	.9701
				TRow	.1305	.5542	.2878	.9725
				TOvl	.1305	.0000	.8683	.9988
8	.40	.36056	.12248	PLAN	.0000	.0000	.9223	.9223
				FISH	.1233	.0000	.8016	.9249
				KEP	.1233	.5643	.2502	.9378
				MB	.1233	.6787	.1515	.9535
				MBB	.1233	.6850	.1463	.9546
				BON	.1233	.7394	.1012	.9639
				TRow	.1233	.5643	.2784	.9660
				TOvl	.1233	.0000	.8744	.9977
8	.40	.36056	.30619	PLAN	.0000	.0000	.7755	.7755
				FISH	.1233	.0000	.6627	.7860
				KEP	.1233	.5643	.1419	.8295
				MB	.1233	.6787	.0749	.8769
				MBB	.1233	.6850	.0718	.8801
				BON	.1233	.7394	.0468	.9095
				TRow	.1233	.5643	.1925	.8801
				TOvl	.1233	.0000	.8624	.9857
8	.40	.36056	.31819	PLAN	.0000	.0000	.7591	.7591
				FISH	.1305	.0000	.6345	.7650
				KEP	.1305	.5542	.1285	.8132
				MB	.1305	.6704	.0681	.8690
				MBB	.1305	.6778	.0642	.8725
				BON	.1305	.7336	.0397	.9038
				TRow	.1305	.5542	.1831	.8678
				TOvl	.1305	.0000	.8537	.9842
8	.40	.36056	.42426	PLAN	.0000	.0000	.6132	.6132
				FISH	.1305	.0000	.4996	.6301
				KEP	.1305	.5542	.0388	.7235
				MB	.1305	.6704	.0150	.8159
				MBB	.1305	.6778	.0141	.8224
				BON	.1305	.7336	.0076	.8717
				TRow	.1305	.5542	.0816	.7663
				TOvl	.1305	.0000	.8300	.9605
8	.40	.36056	.42866	PLAN	.0000	.0000	.6074	.6074
				FISH	.1233	.0000	.4986	.6219
				KEP	.1233	.5643	.0345	.7221
				MB	.1233	.6787	.0134	.8154
				MBB	.1233	.6850	.0125	.8208
				BON	.1233	.7394	.0064	.8691
				TRow	.1233	.5643	.0739	.7615
				TOvl	.1233	.0000	.8342	.9575

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.40	.35000	.06124	PLAN	.0000	.0000	.9450	.9450
				FISH	.1263	.0000	.8243	.9506
				KEP	.1263	.5782	.2550	.9595
				MB	.1263	.6884	.1556	.9703
				MBB	.1263	.6946	.1500	.9709
				BON	.1263	.7467	.1042	.9772
				TRow	.1263	.5782	.2763	.9808
				TOvl	.1263	.0000	.8727	.9990
8	.40	.35000	.15910	PLAN	.0000	.0000	.9057	.9057
				FISH	.1268	.0000	.7804	.9072
				KEP	.1268	.5775	.2196	.9239
				MB	.1268	.6876	.1305	.9449
				MBB	.1268	.6945	.1254	.9467
				BON	.1268	.7472	.0864	.9604
				TRow	.1268	.5775	.2523	.9566
				TOvl	.1268	.0000	.8707	.9975
8	.40	.35000	.26517	PLAN	.0000	.0000	.8190	.8190
				FISH	.1268	.0000	.7084	.8352
				KEP	.1268	.5775	.1624	.8667
				MB	.1268	.6876	.0886	.9030
				MBB	.1268	.6945	.0843	.9056
				BON	.1268	.7472	.0531	.9271
				TRow	.1268	.5775	.2080	.9123
				TOvl	.1268	.0000	.8633	.9901
8	.40	.35000	.33681	PLAN	.0000	.0000	.7333	.7333
				FISH	.1263	.0000	.6131	.7394
				KEP	.1263	.5782	.0948	.7993
				MB	.1263	.6884	.0469	.8616
				MBB	.1263	.6946	.0446	.8655
				BON	.1263	.7467	.0281	.9011
				TRow	.1263	.5782	.1475	.8520
				TOvl	.1263	.0000	.8537	.9800
8	.40	.35000	.39804	PLAN	.0000	.0000	.6473	.6473
				FISH	.1263	.0000	.5451	.6714
				KEP	.1263	.5782	.0497	.7542
				MB	.1263	.6884	.0209	.8356
				MBB	.1263	.6946	.0198	.8407
				BON	.1263	.7467	.0117	.8847
				TRow	.1263	.5782	.0932	.7977
				TOvl	.1263	.0000	.8403	.9666
8	.40	.35000	.42426	PLAN	.0000	.0000	.6075	.6075
				FISH	.1268	.0000	.4986	.6254
				KEP	.1268	.5775	.0255	.7298
				MB	.1268	.6876	.0087	.8231
				MBB	.1268	.6945	.0081	.8294
				BON	.1268	.7472	.0036	.8776
				TRow	.1268	.5775	.0594	.7637
				TOvl	.1268	.0000	.8298	.9566

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.25	.43302	.26517	PLAN	.0000	.0000	.8171	.8171
				FISH	.5850	.0000	.3061	.8911
				KEP	.5850	.1658	.1494	.9002
				MB	.5850	.2243	.1058	.9151
				MBB	.5850	.2273	.1036	.9159
				BON	.5850	.2589	.0823	.9262
				TRow	.5850	.1658	.1828	.9336
				TOvl	.5850	.0000	.4068	.9918
8	.25	.43302	.45928	PLAN	.0000	.0000	.5506	.5506
				FISH	.5862	.0000	.1756	.7618
				KEP	.5862	.1628	.0432	.7922
				MB	.5862	.2218	.0247	.8327
				MBB	.5862	.2255	.0238	.8355
				BON	.5862	.2630	.0162	.8654
				TRow	.5862	.1628	.0789	.8279
				TOvl	.5862	.0000	.3676	.9538
8	.25	.43302	.53032	PLAN	.0000	.0000	.4542	.4542
				FISH	.5850	.0000	.1360	.7210
				KEP	.5850	.1658	.0144	.7652
				MB	.5850	.2243	.0056	.8149
				MBB	.5850	.2273	.0053	.8176
				BON	.5850	.2589	.0036	.8475
				TRow	.5850	.1658	.0309	.7817
				TOvl	.5850	.0000	.3441	.9291
8	.25	.50000	.30619	PLAN	.0000	.0000	.7729	.7729
				FISH	.5862	.0000	.2845	.8707
				KEP	.5862	.1107	.1797	.8766
				MB	.5862	.1610	.1403	.8875
				MBB	.5862	.1640	.1379	.8881
				BON	.5862	.2026	.1102	.8990
				TRow	.5862	.1107	.2200	.9169
				TOvl	.5862	.0000	.4014	.9876
8	.25	.50000	.53032	PLAN	.0000	.0000	.4435	.4435
				FISH	.5850	.0000	.1350	.7200
				KEP	.5850	.1165	.0431	.7446
				MB	.5850	.1671	.0271	.7792
				MBB	.5850	.1716	.0263	.7829
				BON	.5850	.2066	.0181	.8097
				TRow	.5850	.1165	.0770	.7785
				TOvl	.5850	.0000	.3416	.9266
8	.25	.50000	.61238	PLAN	.0000	.0000	.3219	.3219
				FISH	.5862	.0000	.0849	.6711
				KEP	.5862	.1107	.0084	.7053
				MB	.5862	.1610	.0035	.7507
				MBB	.5862	.1640	.0033	.7535
				BON	.5862	.2026	.0019	.7907
				TRow	.5862	.1107	.0229	.7198
				TOvl	.5862	.0000	.2952	.8814

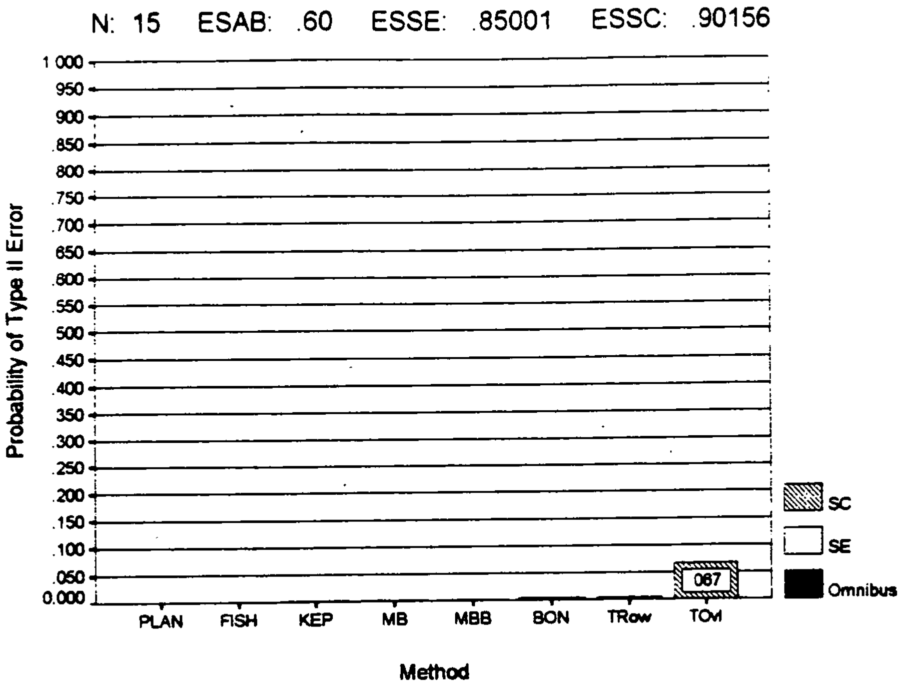
N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.25	.31225	.27556	PLAN	.0000	.0000	.8125	.8125
				FISH	.5858	.0000	.3010	.8868
				KEP	.5858	.2460	.0752	.9070
				MB	.5858	.3060	.0414	.9332
				MBB	.5858	.3099	.0396	.9353
				BON	.5858	.3376	.0260	.9494
				TRow	.5858	.2460	.1018	.9336
				TOvl	.5858	.0000	.4047	.9905
8	.25	.31225	.36742	PLAN	.0000	.0000	.6925	.6925
				FISH	.5858	.0000	.2222	.8080
				KEP	.5858	.2460	.0193	.8511
				MB	.5858	.3060	.0081	.8999
				MBB	.5858	.3099	.0070	.9027
				BON	.5858	.3376	.0039	.9273
				TRow	.5858	.2460	.0410	.8728
				TOvl	.5858	.0000	.3904	.9762
8	.25	.31225	.37123	PLAN	.0000	.0000	.6821	.6821
				FISH	.5841	.0000	.2254	.8095
				KEP	.5841	.2420	.0242	.8503
				MB	.5841	.2988	.0114	.8943
				MBB	.5841	.3010	.0112	.8963
				BON	.5841	.3330	.0071	.9242
				TRow	.5841	.2420	.0460	.8721
				TOvl	.5841	.0000	.3899	.9740
8	.25	.35000	.21433	PLAN	.0000	.0000	.8655	.8655
				FISH	.5858	.0000	.3285	.9143
				KEP	.5858	.2173	.1237	.9268
				MB	.5858	.2772	.0785	.9415
				MBB	.5858	.2802	.0764	.9424
				BON	.5858	.3120	.0553	.9531
				TRow	.5858	.2173	.1502	.9533
				TOvl	.5858	.0000	.4089	.9947
8	.25	.35000	.37123	PLAN	.0000	.0000	.6851	.6851
				FISH	.5841	.0000	.2307	.8148
				KEP	.5841	.2162	.0464	.8467
				MB	.5841	.2784	.0243	.8868
				MBB	.5841	.2824	.0227	.8892
				BON	.5841	.3167	.0141	.9149
				TRow	.5841	.2162	.0751	.8754
				TOvl	.5841	.0000	.3928	.9769
8	.25	.35000	.42866	PLAN	.0000	.0000	.5996	.5996
				FISH	.5858	.0000	.1856	.7714
				KEP	.5858	.2173	.0149	.8180
				MB	.5858	.2772	.0064	.8694
				MBB	.5858	.2802	.0061	.8721
				BON	.5858	.3120	.0039	.9017
				TRow	.5858	.2173	.0349	.8380
				TOvl	.5858	.0000	.3770	.9628

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	TYPE II ERROR PER SC	OVERALL TYPE II ERROR
8	.25	.25000	.15309	PLAN	.0000	.0000	.9071	.9071
				FISH	.5854	.0000	.3514	.9368
				KEP	.5854	.2856	.0796	.9506
				MB	.5854	.3363	.0445	.9662
				MBB	.5854	.3390	.0428	.9672
				BON	.5854	.3626	.0280	.9760
				TRow	.5854	.2856	.0970	.9680
				TOvl	.5854	.0000	.4121	.9975
8	.25	.25000	.26517	PLAN	.0000	.0000	.8174	.8174
				FISH	.5837	.0000	.2919	.8756
				KEP	.5837	.2869	.0370	.9076
				MB	.5837	.3384	.0174	.9395
				MBB	.5837	.3410	.0168	.9415
				BON	.5837	.3643	.0097	.9577
				TRow	.5837	.2869	.0569	.9275
				TOvl	.5837	.0000	.4066	.9903
8	.25	.25000	.30619	PLAN	.0000	.0000	.7743	.7743
				FISH	.5854	.0000	.2636	.8490
				KEP	.5854	.2856	.0185	.8895
				MB	.5854	.3363	.0070	.9287
				MBB	.5854	.3390	.0066	.9310
				BON	.5854	.3626	.0035	.9515
				TRow	.5854	.2856	.0353	.9063
				TOvl	.5854	.0000	.4002	.9856
8	.25	.31225	.09186	PLAN	.0000	.0000	.9317	.9317
				FISH	.5858	.0000	.3679	.9537
				KEP	.5858	.2460	.1297	.9615
				MB	.5858	.3060	.0801	.9719
				MBB	.5858	.3099	.0769	.9726
				BON	.5858	.3376	.0552	.9786
				TRow	.5858	.2460	.1493	.9811
				TOvl	.5858	.0000	.4131	.9989
8	.25	.31225	.10606	PLAN	.0000	.0000	.9304	.9304
				FISH	.5841	.0000	.3732	.9573
				KEP	.5841	.2420	.1366	.9627
				MB	.5841	.2988	.0887	.9716
				MBB	.5841	.3010	.0871	.9722
				BON	.5841	.3330	.0612	.9783
				TRow	.5841	.2420	.1536	.9797
				TOvl	.5841	.0000	.4137	.9978
8	.25	.31225	.26517	PLAN	.0000	.0000	.8117	.8117
				FISH	.5841	.0000	.2885	.8726
				KEP	.5841	.2420	.0710	.8971
				MB	.5841	.2988	.0416	.9245
				MBB	.5841	.3010	.0402	.9253
				BON	.5841	.3330	.0262	.9433
				TRow	.5841	.2420	.0965	.9226
				TOvl	.5841	.0000	.4059	.9900

N	ESAB	ESSE	ESSC	METHOD	OMNIBUS	TYPE II ERROR PER SE	SC	OVERALL TYPE II ERROR
8	.25	.21795	.03062	PLAN	.0000	.0000	.9462	.9462
				FISH	.5858	.0000	.3773	.9631
				KEP	.5858	.3069	.0800	.9727
				MB	.5858	.3536	.0432	.9826
				MBB	.5858	.3561	.0413	.9832
				BON	.5858	.3760	.0266	.9884
				TRow	.5858	.3069	.0920	.9847
				TOvl	.5858	.0000	.4134	.9992
8	.25	.21795	.10606	PLAN	.0000	.0000	.9302	.9302
				FISH	.5841	.0000	.3731	.9572
				KEP	.5841	.3085	.0748	.9674
				MB	.5841	.3536	.0410	.9787
				MBB	.5841	.3563	.0389	.9793
				BON	.5841	.3761	.0247	.9849
				TRow	.5841	.3085	.0873	.9799
				TOvl	.5841	.0000	.4143	.9984
8	.25	.21795	.15910	PLAN	.0000	.0000	.9020	.9020
				FISH	.5841	.0000	.3429	.9270
				KEP	.5841	.3085	.0553	.9479
				MB	.5841	.3536	.0289	.9666
				MBB	.5841	.3563	.0276	.9680
				BON	.5841	.3761	.0177	.9779
				TRow	.5841	.3085	.0725	.9651
				TOvl	.5841	.0000	.4130	.9971
8	.25	.21795	.21433	PLAN	.0000	.0000	.8637	.8637
				FISH	.5858	.0000	.3288	.9146
				KEP	.5858	.3069	.0436	.9363
				MB	.5858	.3536	.0203	.9597
				MBB	.5858	.3561	.0191	.9610
				BON	.5858	.3760	.0111	.9729
				TRow	.5858	.3069	.0600	.9527
				TOvl	.5858	.0000	.4097	.9955
8	.25	.21795	.24495	PLAN	.0000	.0000	.8359	.8359
				FISH	.5858	.0000	.2978	.8836
				KEP	.5858	.3069	.0259	.9186
				MB	.5858	.3536	.0113	.9507
				MBB	.5858	.3561	.0109	.9528
				BON	.5858	.3760	.0058	.9676
				TRow	.5858	.3069	.0427	.9354
				TOvl	.5858	.0000	.4068	.9926
8	.25	.21795	.26517	PLAN	.0000	.0000	.8150	.8150
				FISH	.5841	.0000	.2912	.8753
				KEP	.5841	.3085	.0198	.9124
				MB	.5841	.3536	.0079	.9456
				MBB	.5841	.3563	.0073	.9477
				BON	.5841	.3761	.0037	.9639
				TRow	.5841	.3085	.0351	.9277
				TOvl	.5841	.0000	.4069	.9910

APPENDIX D:

OVERALL TYPE II ERROR AND TYPE II ERROR AT EACH LEVEL OF ANALYSIS


N: 15 ESAB: .60 ESSE: .85001 ESSC: .90156
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
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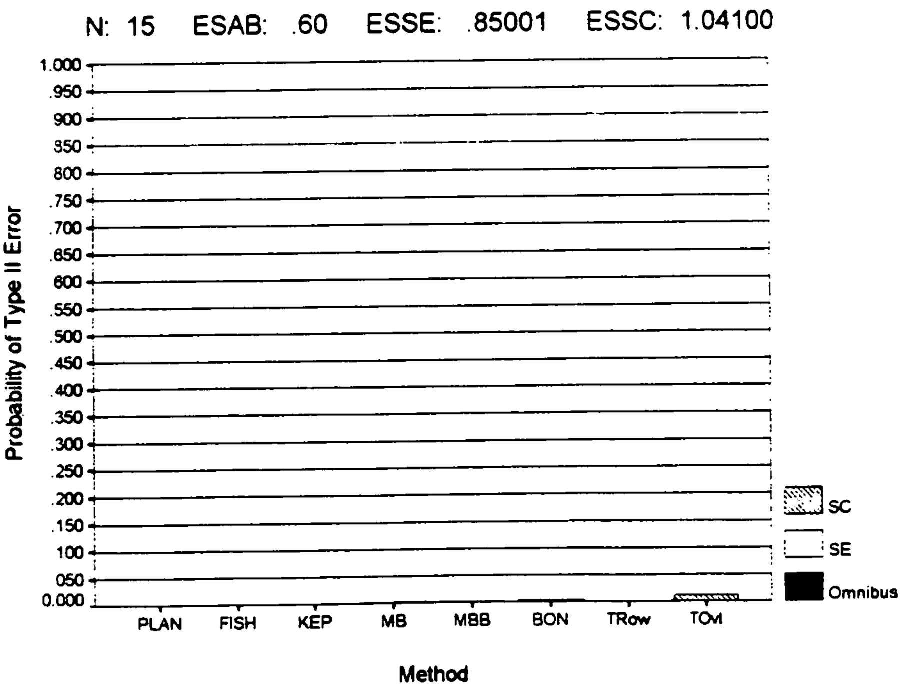
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.087
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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Probability of Type II Error
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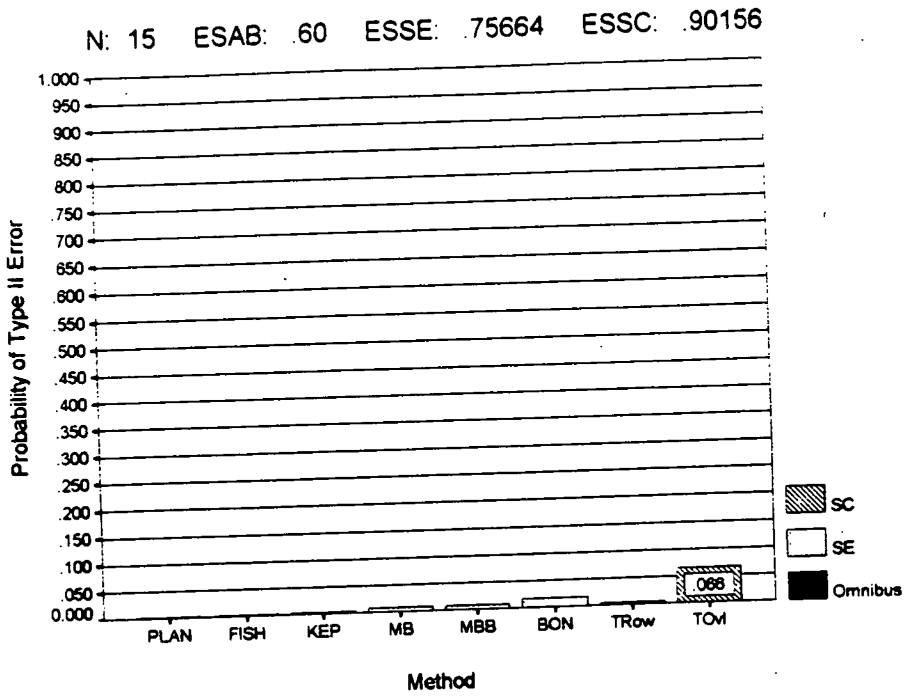
.350
.300
.250
.200
.150
.100
.050
0.000
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 15 ESAB: .60 ESSE: .75664 ESSC: .90156
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
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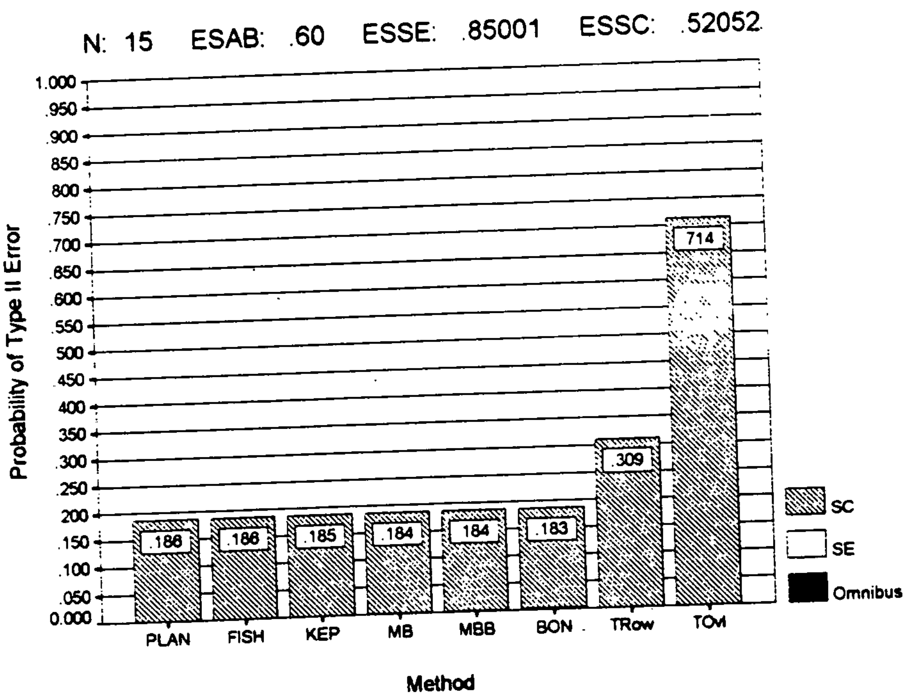
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.068
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 15 ESAB: .60 ESSE: .85001 ESSC: .52052
Probability of Type II Error
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.900
.850
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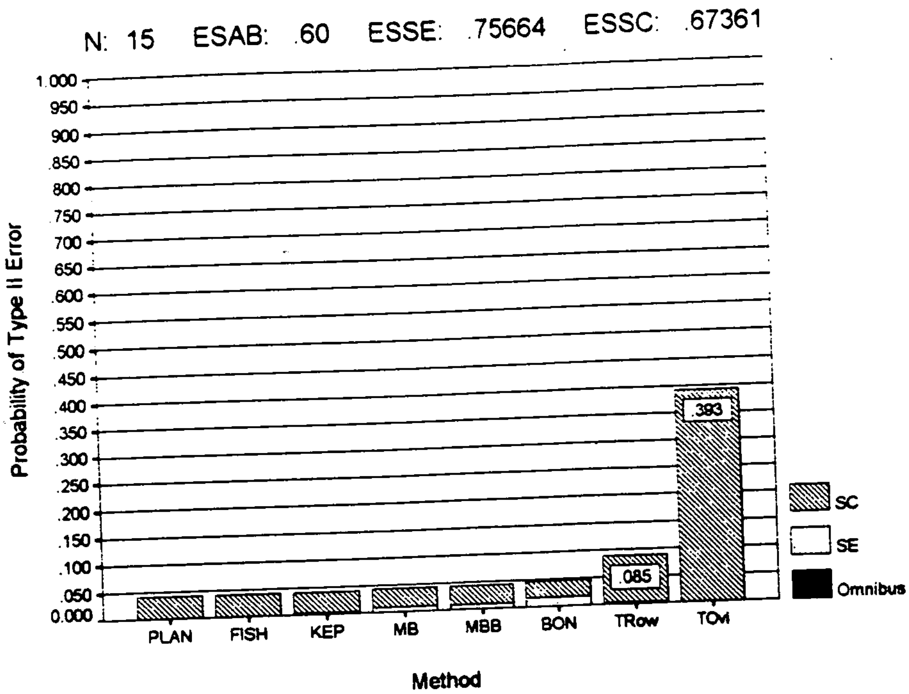
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.186
.186
.185
.184
.184
.183
.309
.714
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .75664 ESSC: .67361
Probability of Type II Error
1.000
.950
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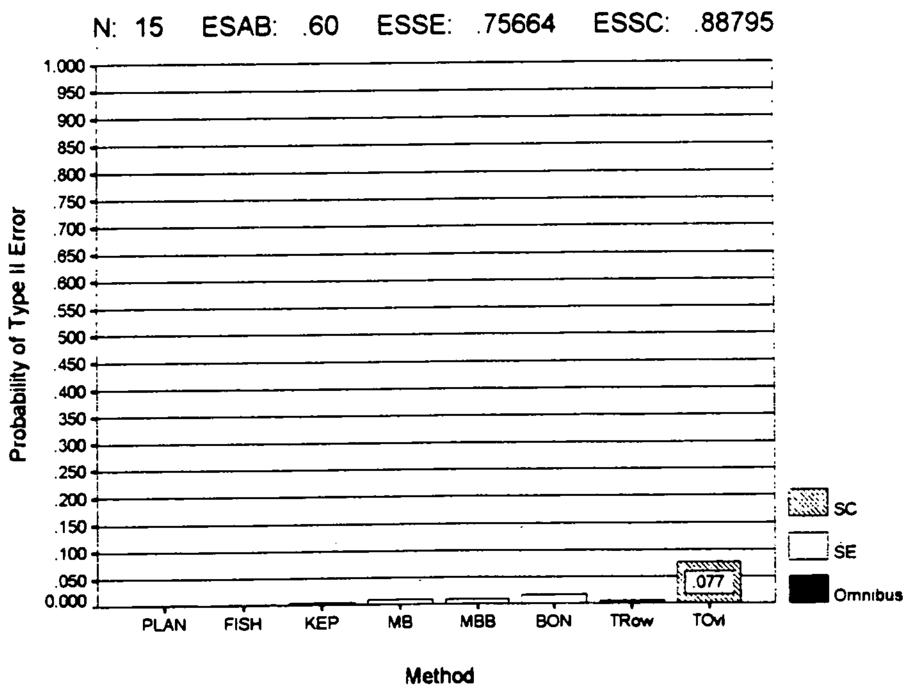
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.393
.085
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .75664 ESSC: .88795
Probability of Type II Error
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.750
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.500
.450
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.350
.300
.250
.200
.150
.100
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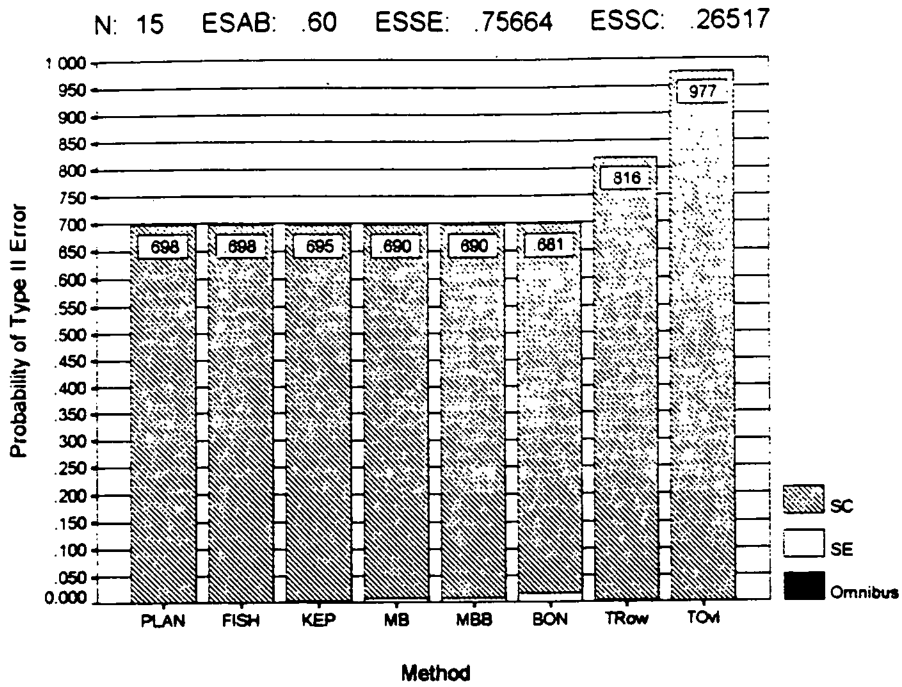
0.000
.077
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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.600
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.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.698
.698
.695
.690
.690
.681
.816
.977
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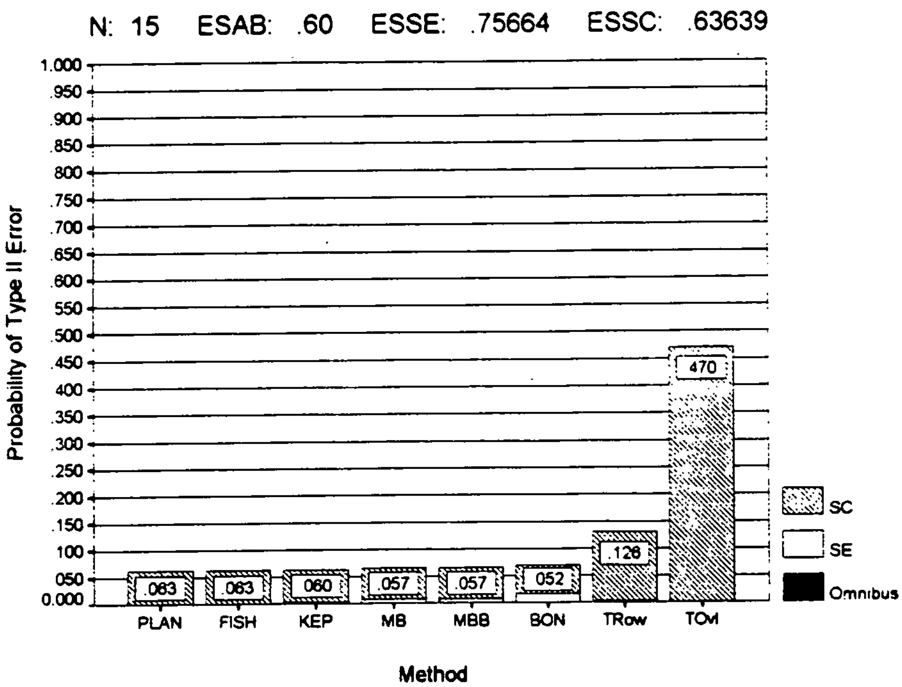
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.063
.063
.060
.057
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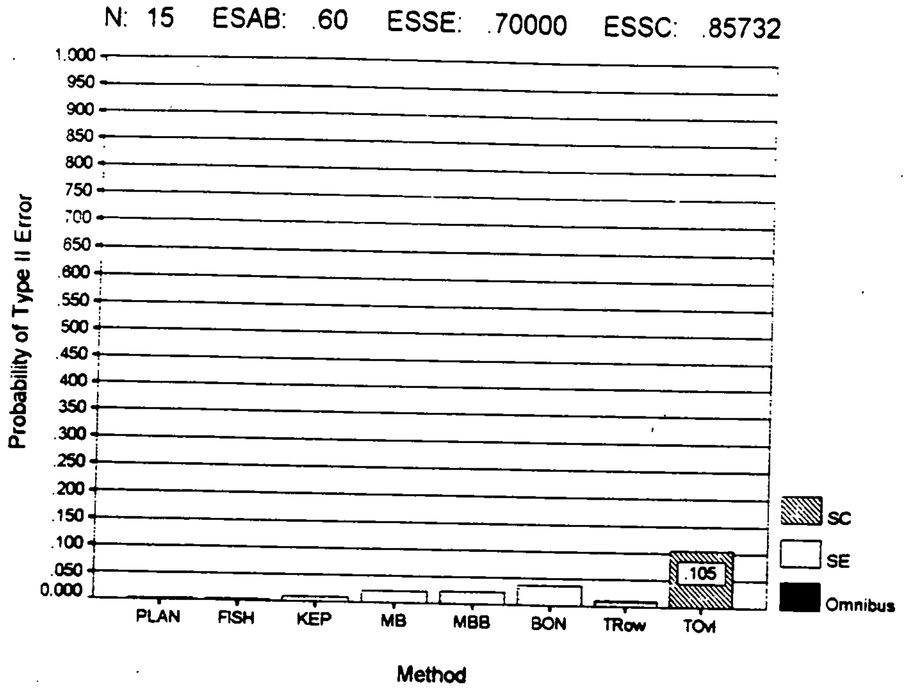
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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.200
.150
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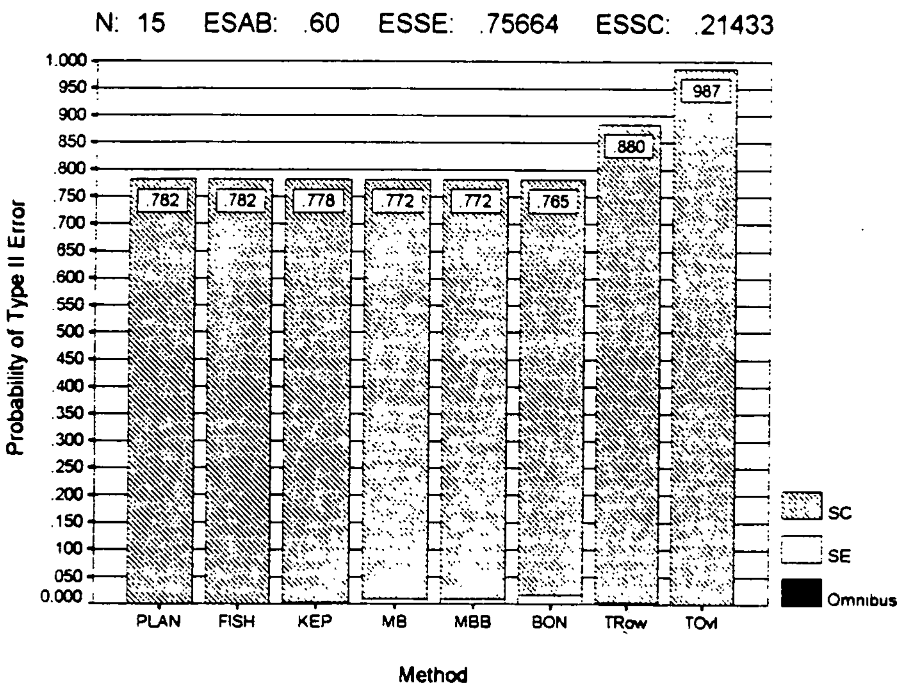
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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.350
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.150
.100
.050
0.000
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.782
.778
.772
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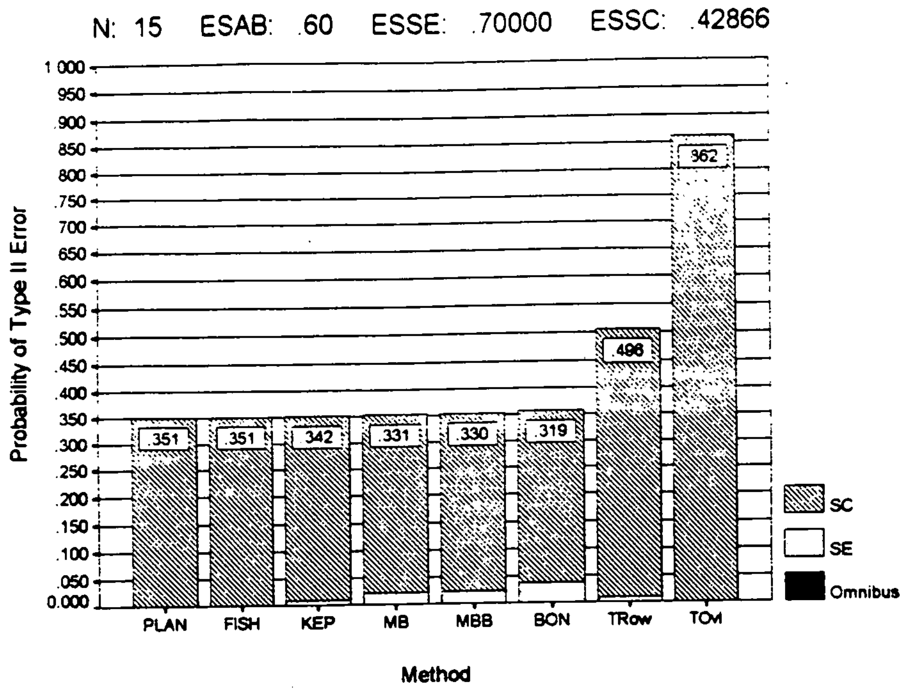
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .70000 ESSC: .42866
Probability of Type II Error
Method
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KEP
MB
MBB
BON
TRow
TOM
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.331
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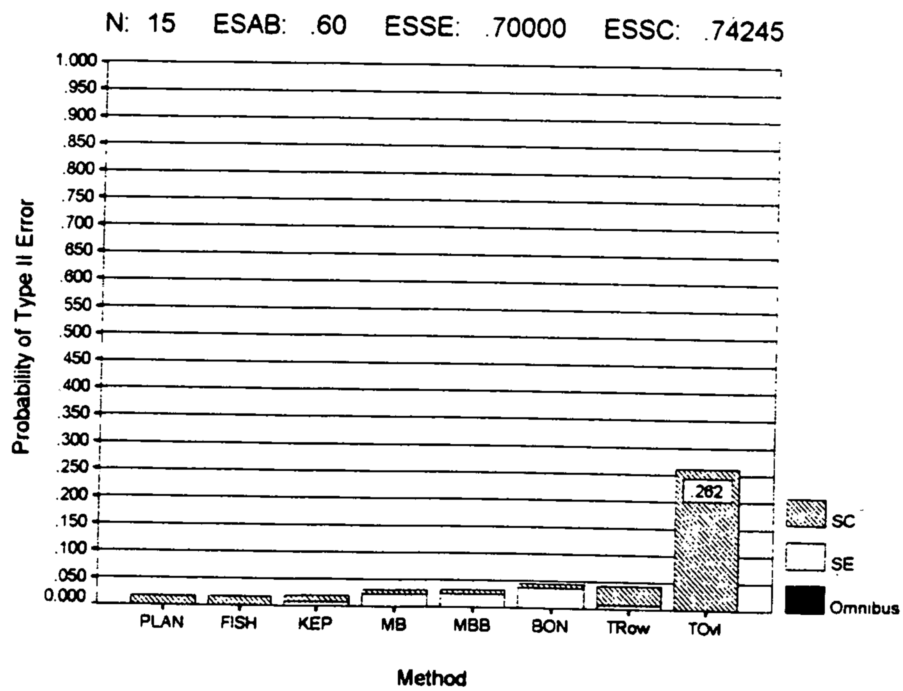
.319
.496
.862
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .70000 ESSC: .74245
Probability of Type II Error
Method
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KEP
MB
MBB
BON
TRow
TOM
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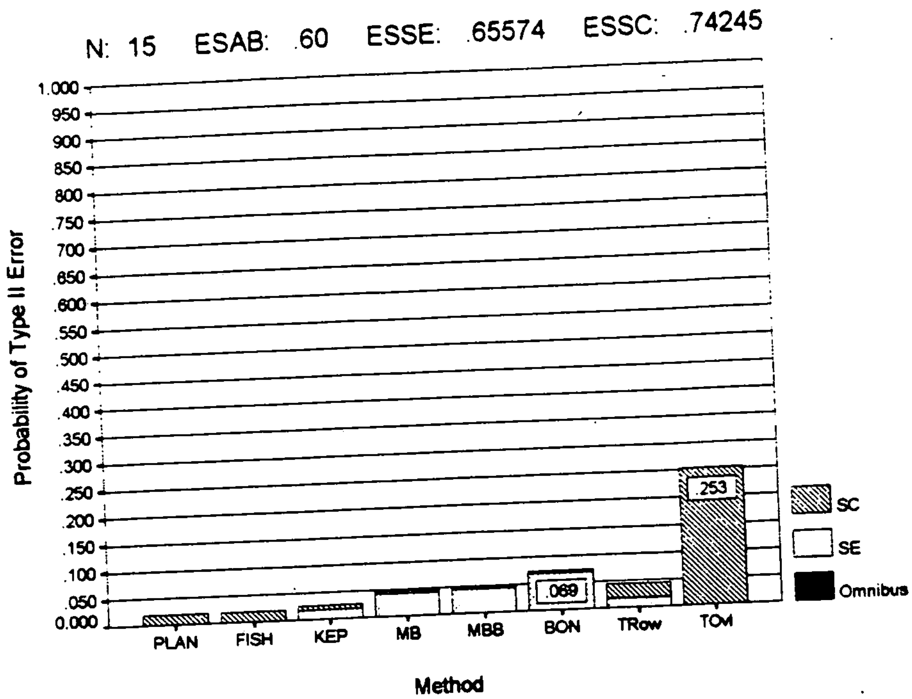
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .65574 ESSC: .74245
Probability of Type II Error
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.200
.150
.100
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0.000
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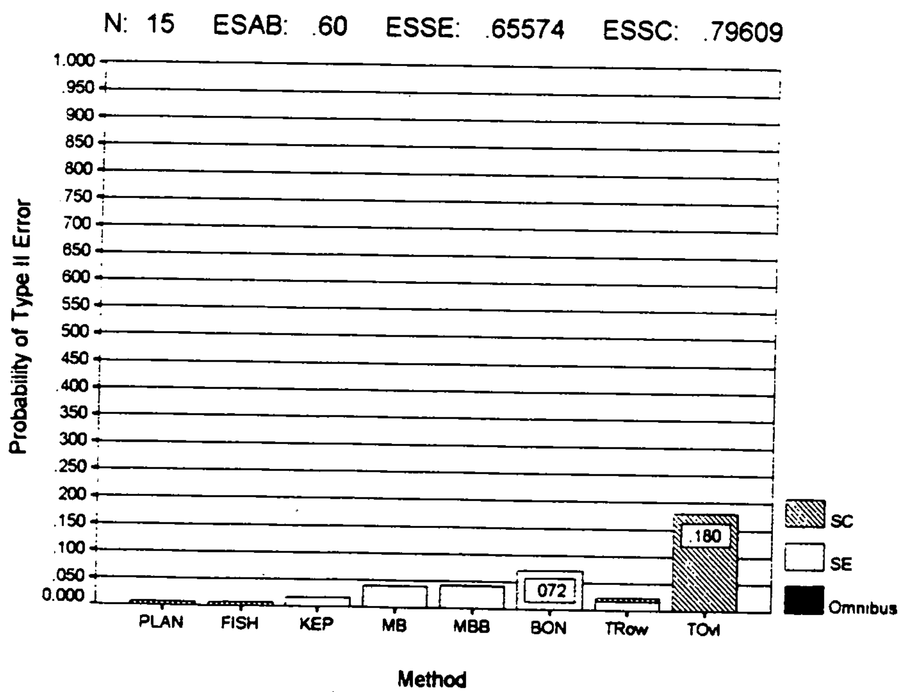
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
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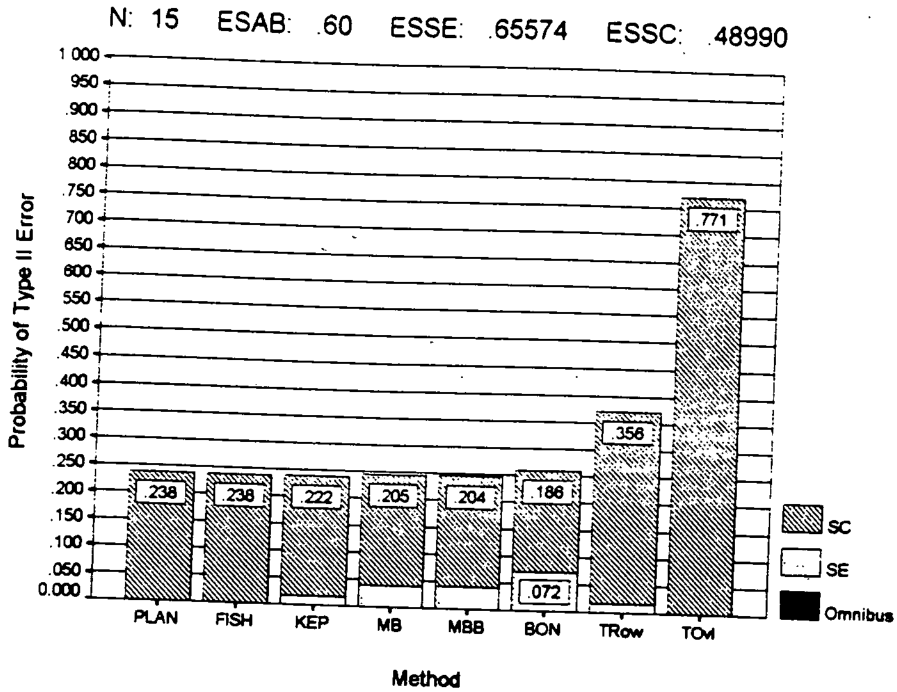
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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0.000
.238
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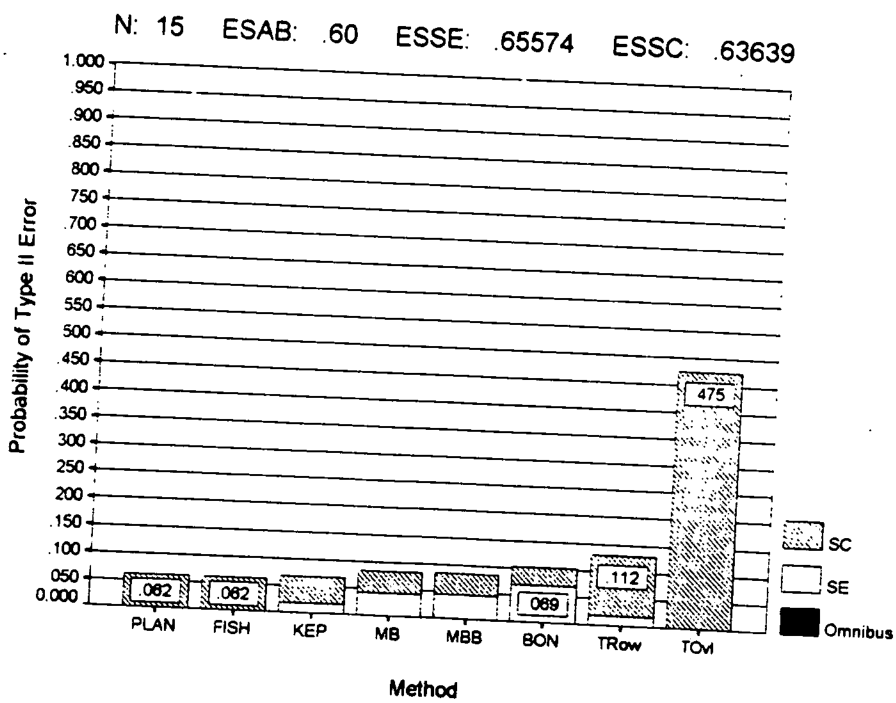
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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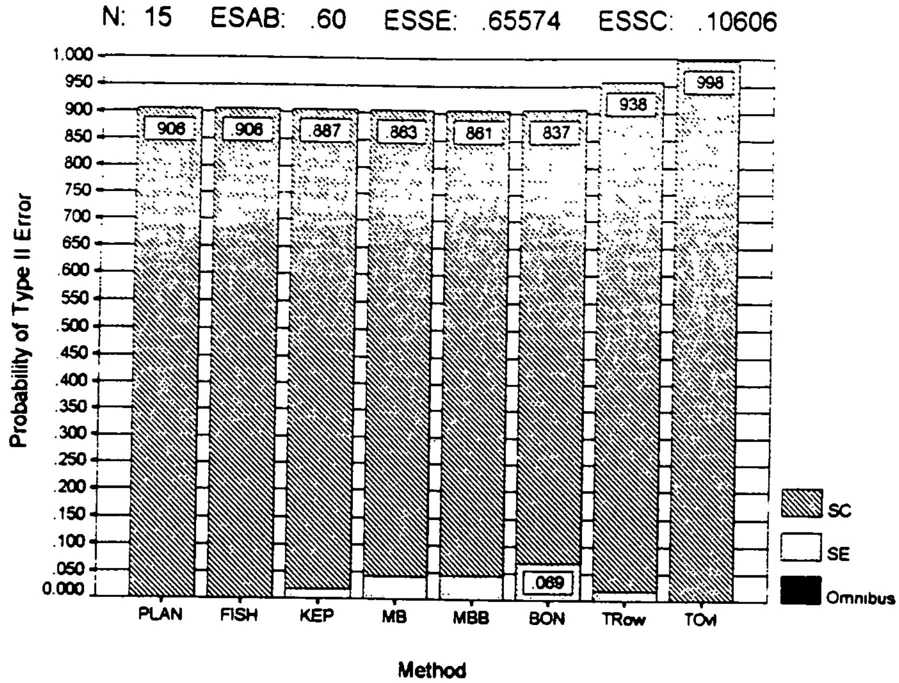
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.062
.062
.069
.112
.475
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .65574 ESSC: .10606
Probability of Type II Error
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.300
.250
.200
.150
.100
.050
0.000
.906
.906
.887
.863
.861
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.938
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.069
PLAN
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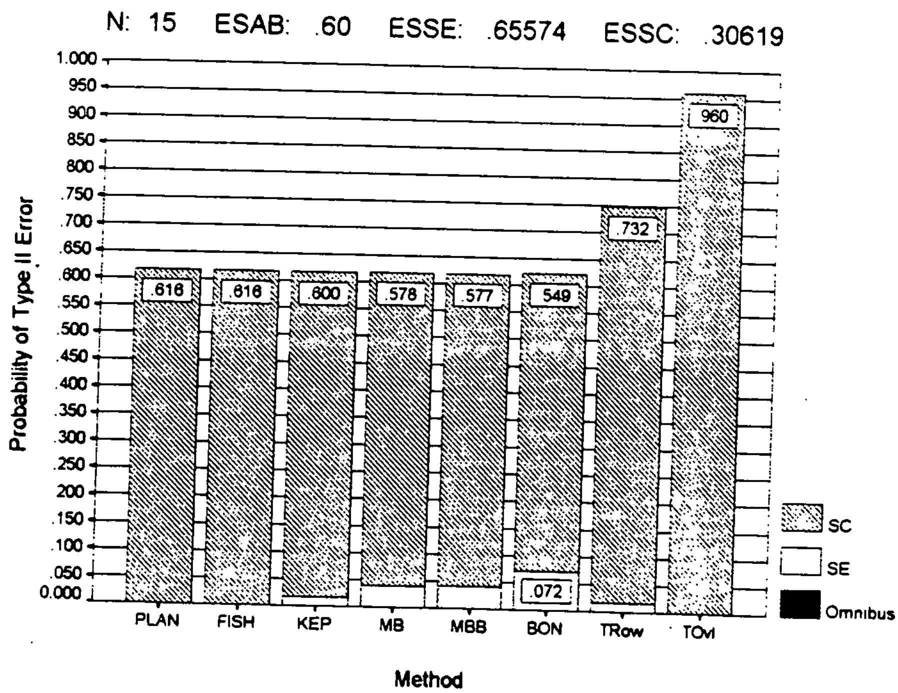
TRow
TOvl
Method
SC
SE
Omnibus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.200
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.100
.050
0.000
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.616
.600
.578
.577
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TRow
TOvl
Method
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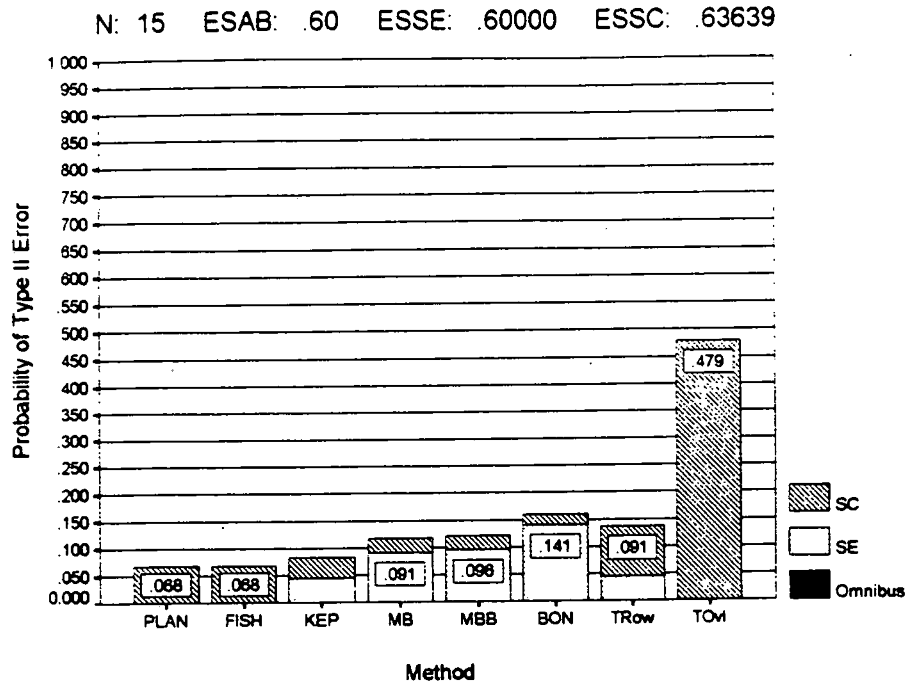
SE
Omnibus


N: 15 ESAB: .60 ESSE: .60000 ESSC: .63639
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.068
.068
.091
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TOvl
Method
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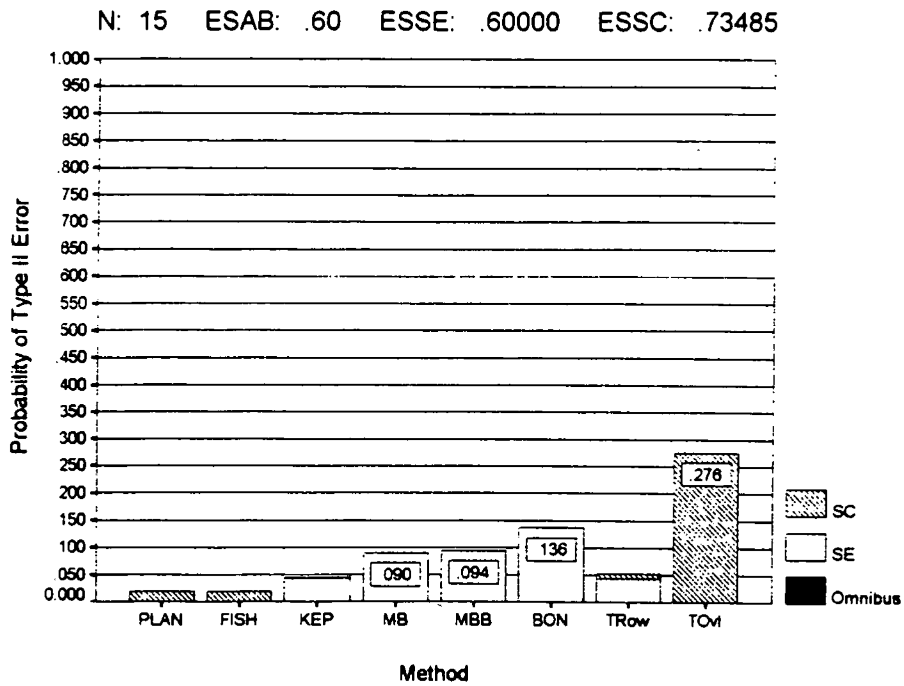
SE
Omnibus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.050
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TRow
TOvl
Method
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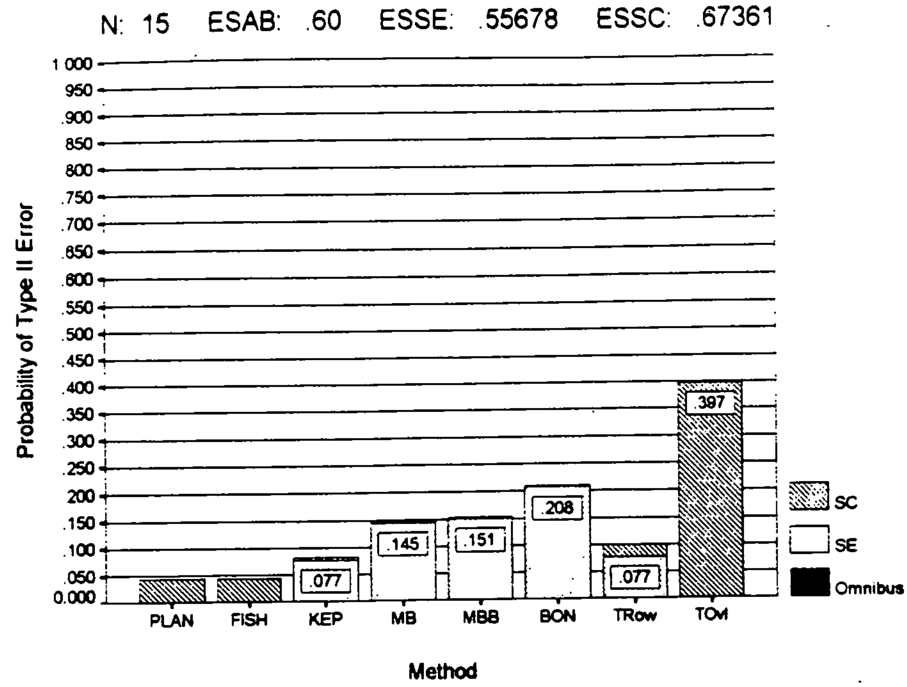
SE
Omnibus


N: 15 ESAB: .60 ESSE: .55678 ESSC: .67361
Probability of Type II Error
Method
PLAN
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.208
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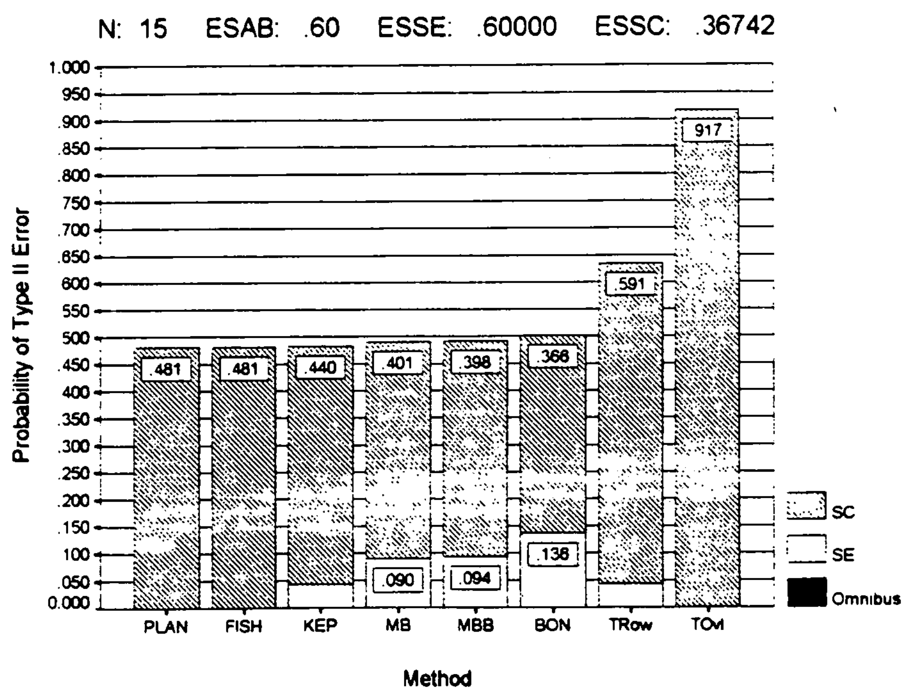
.397
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .60000 ESSC: .36742
Probability of Type II Error
Method
PLAN
FISH
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MB
MBB
BON
TRow
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.440
.401
.398
.368
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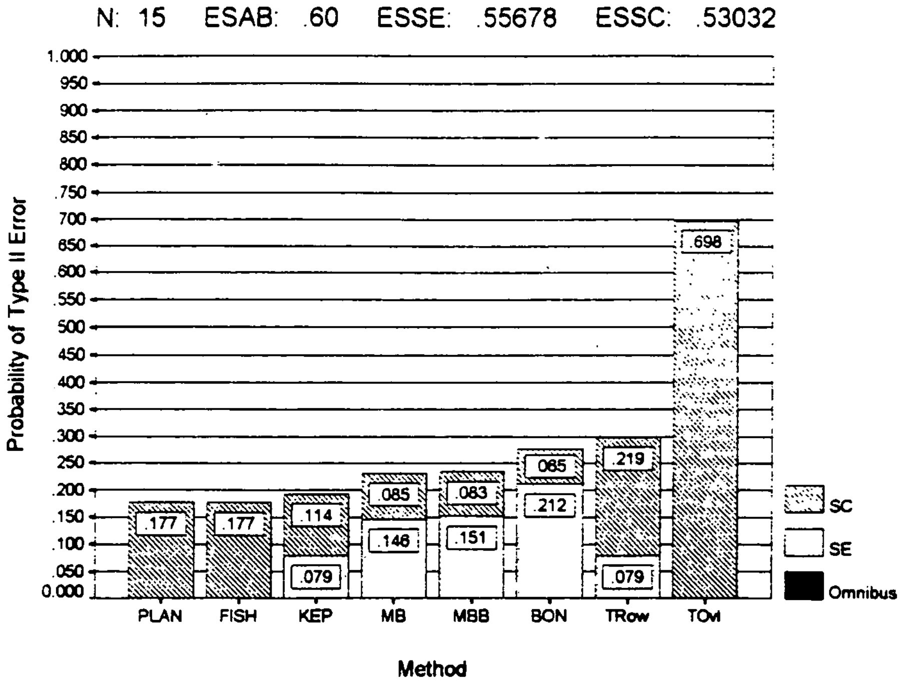
.090
.094
.138
SC
SE
Omnibus



N: 15 ESAB: .60 ESSE: .55678 ESSC: .53032
Probability of Type II Error
.177
.177
.114
.079
.085
.146
.083
.151
.065
.212
.219
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.698
SC
SE
Omnibus
PLAN
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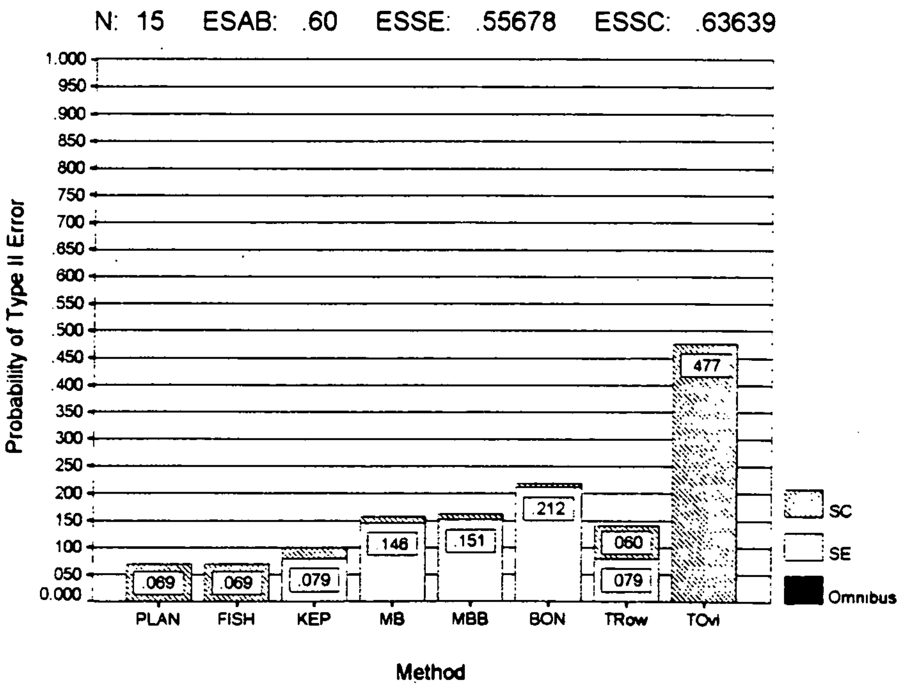
KEP
MB
MBB
BON
TRow
TOvl
Method



N: 15 ESAB: .60 ESSE: .55678 ESSC: .63639
Probability of Type II Error
.069
.069
.079
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.151
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SC
SE
Omnibus
PLAN
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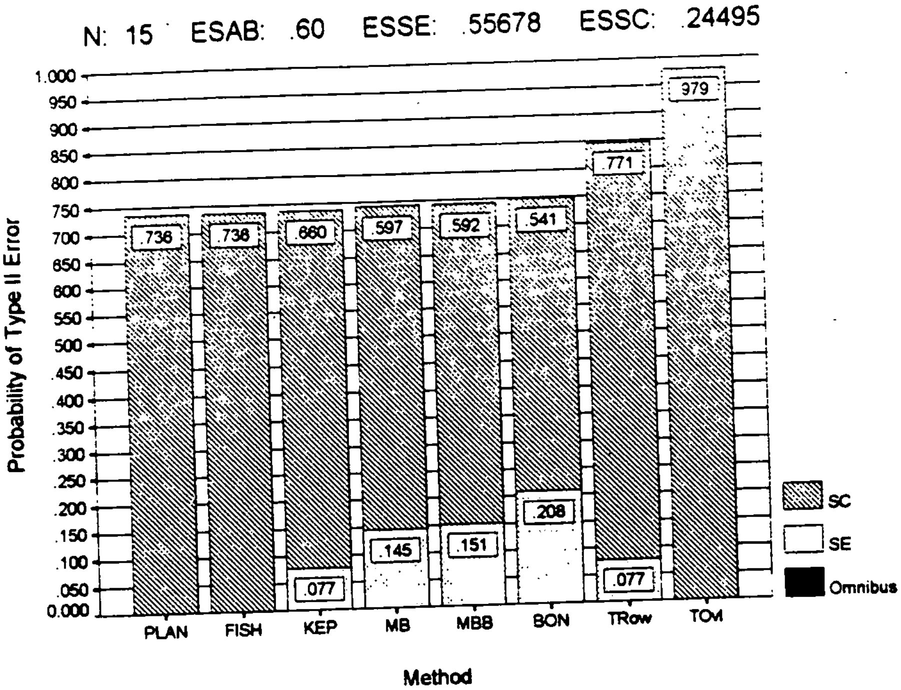
KEP
MB
MBB
BON
TRow
TOvl
Method



N: 15 ESAB: .60 ESSE: .55678 ESSC: .24495
Probability of Type II Error
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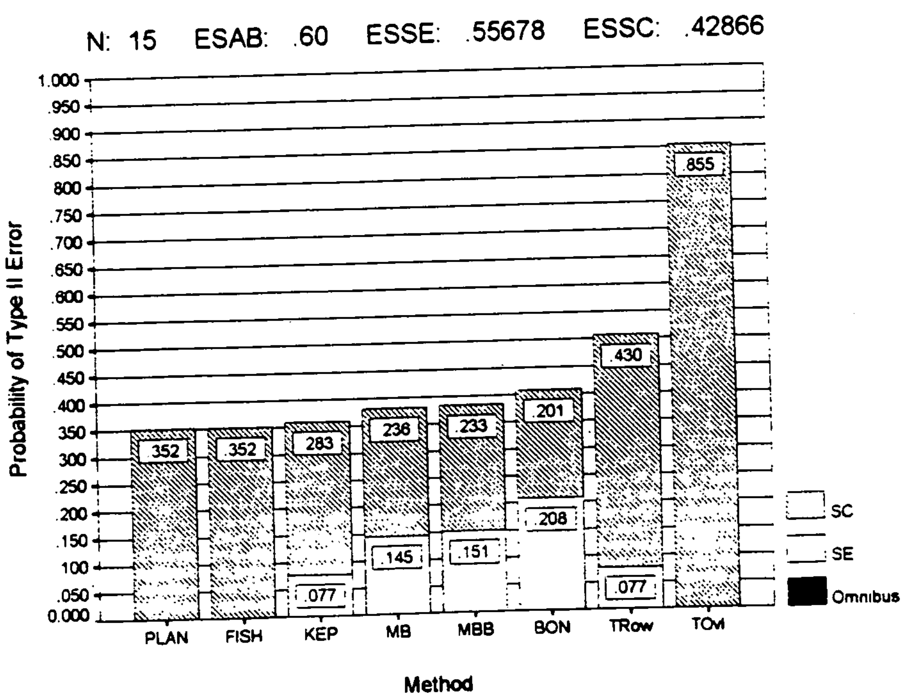
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.736
.738
.660
.597
.592
.541
.771
.979
.077
.145
.151
.208
.077
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus



N: 15 ESAB: .60 ESSE: .55678 ESSC: .42866
Probability of Type II Error
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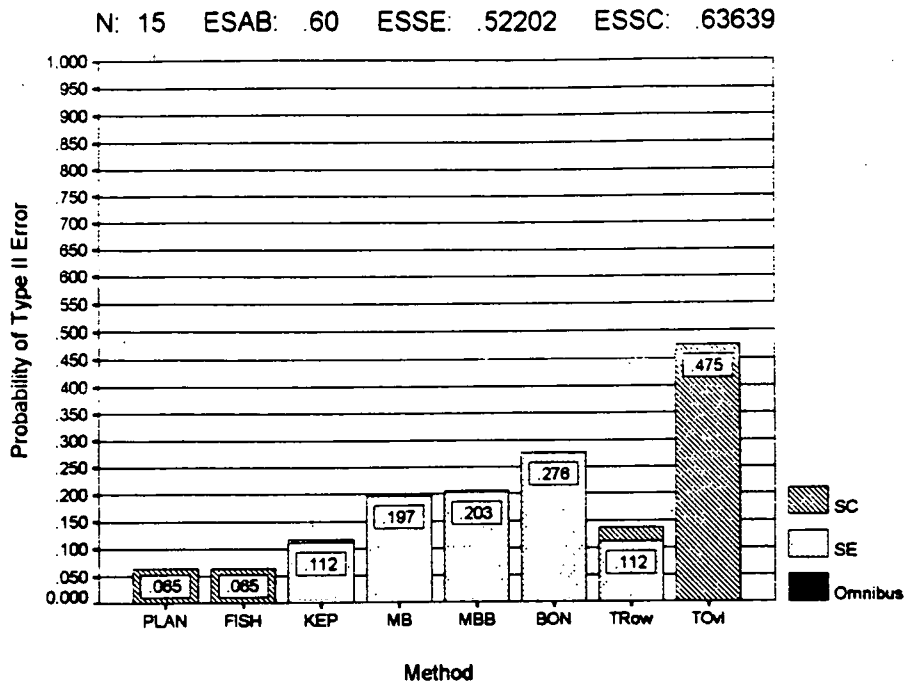
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.352
.352
.283
.236
.233
.201
.430
.855
.077
.145
.151
.208
.077
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .52202 ESSC: .63639
Probability of Type II Error
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.100
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.065
.065
.112
.197
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MB
MBB
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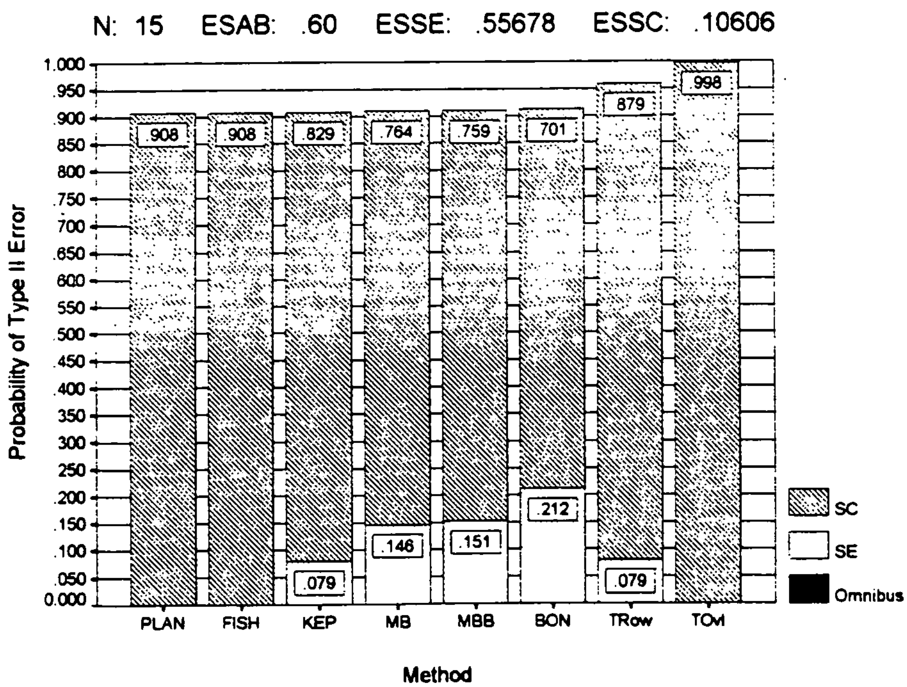
TCM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .55678 ESSC: .10606
Probability of Type II Error
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.300
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.200
.150
.100
.050
0.000
.908
.908
.829
.764
.759
.701
.879
.998
.079
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.151
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.079
PLAN
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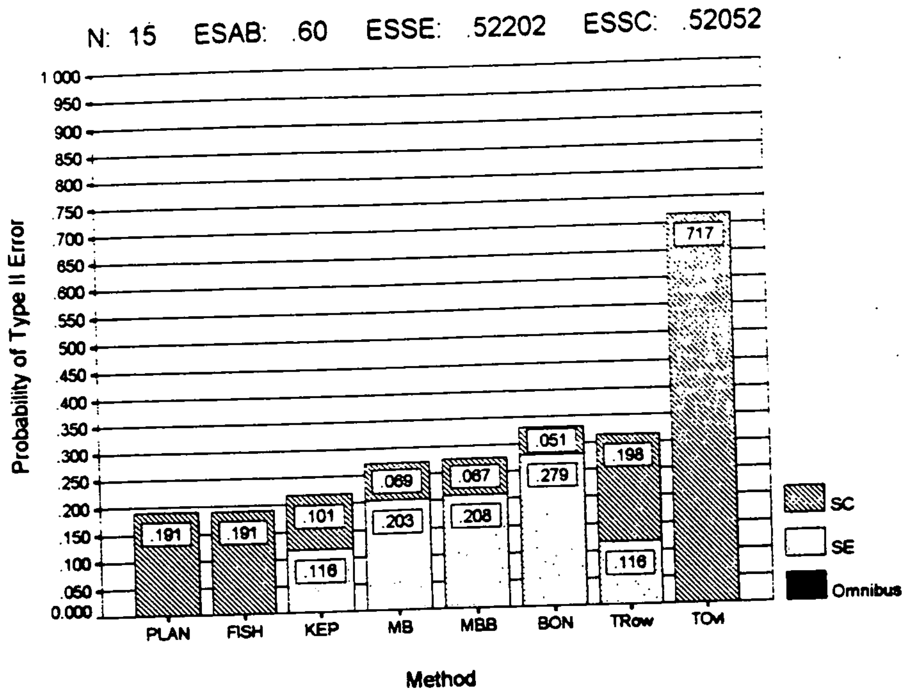
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus


N: 15 ESAB: .60 ESSE: .52202 ESSC: .52052
Probability of Type II Error
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.650
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.500
.450
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.300
.250
.200
.150
.100
.050
0.000
.191
.191
.101
.116
.069
.203
.067
.208
.051
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.717
PLAN
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Method
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SE
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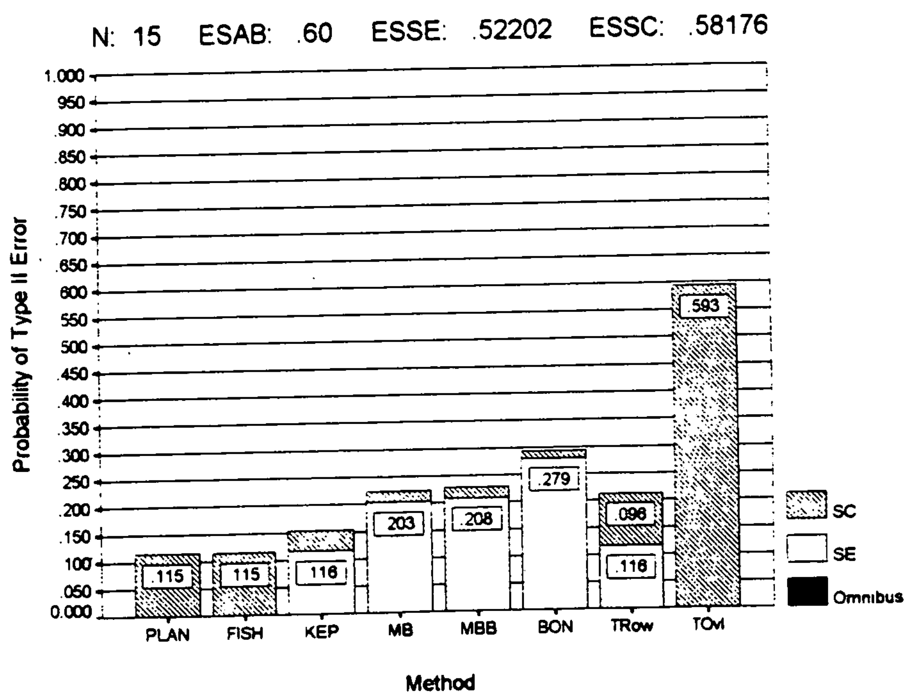
N: 15 ESAB: .60 ESSE: .52202 ESSC: .58176
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.600
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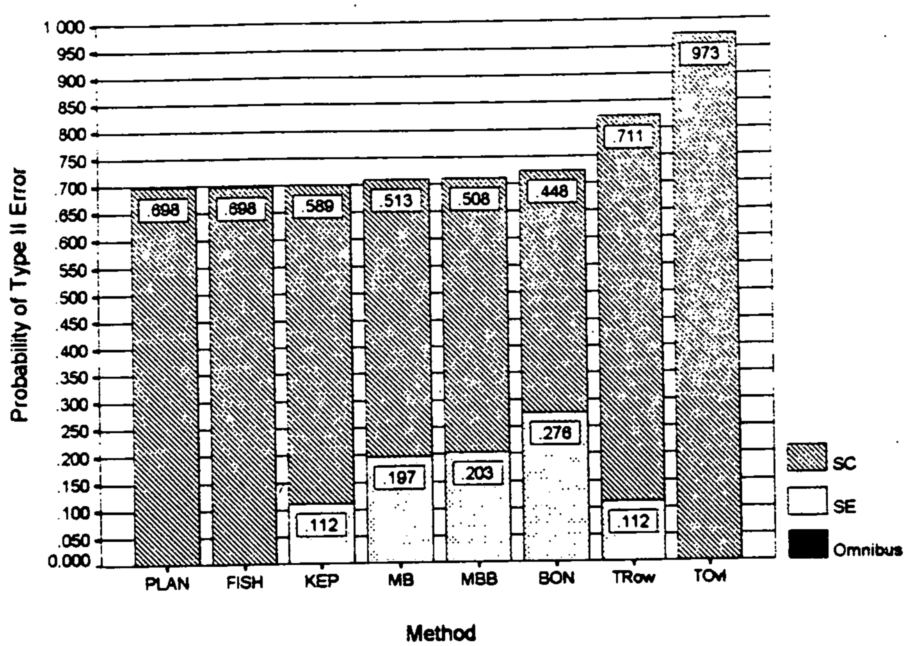
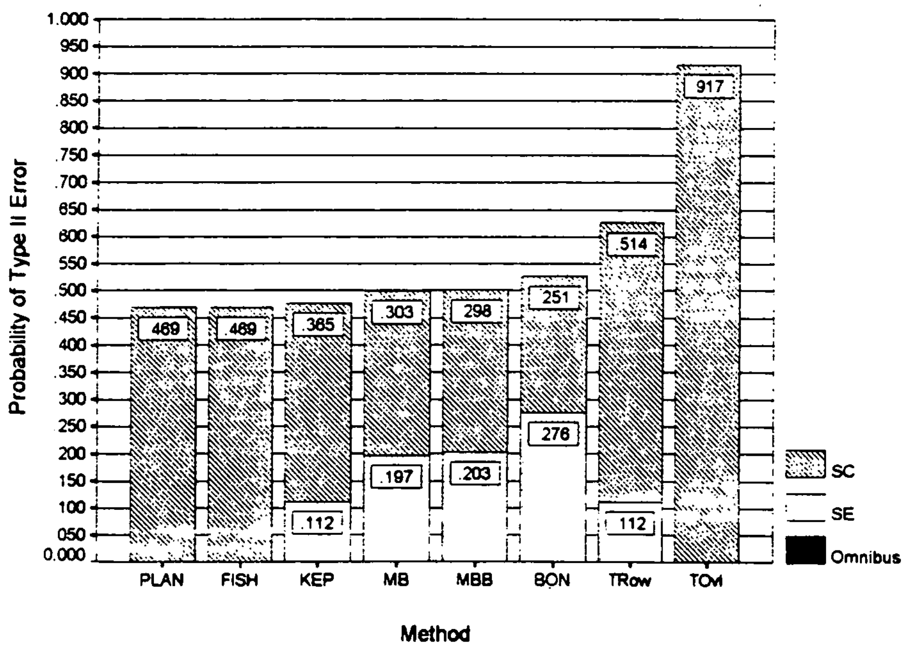
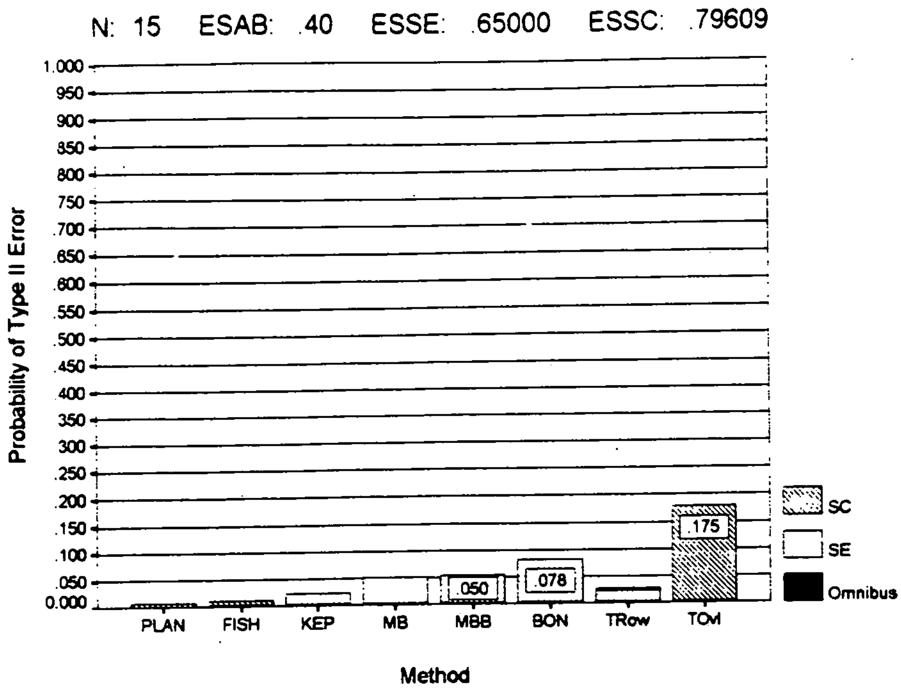
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.115
.115
.116
.203
.208
.279
.096
.116
.593
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus

N: 15 ESAB: .60 ESSE: .52202 ESSC: .26517



N: 15 ESAB: .60 ESSE: .52202 ESSC: .37123

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.250
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.150
.100
.050
0.000
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.175
PLAN
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KEP
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TRow
TOM
Method
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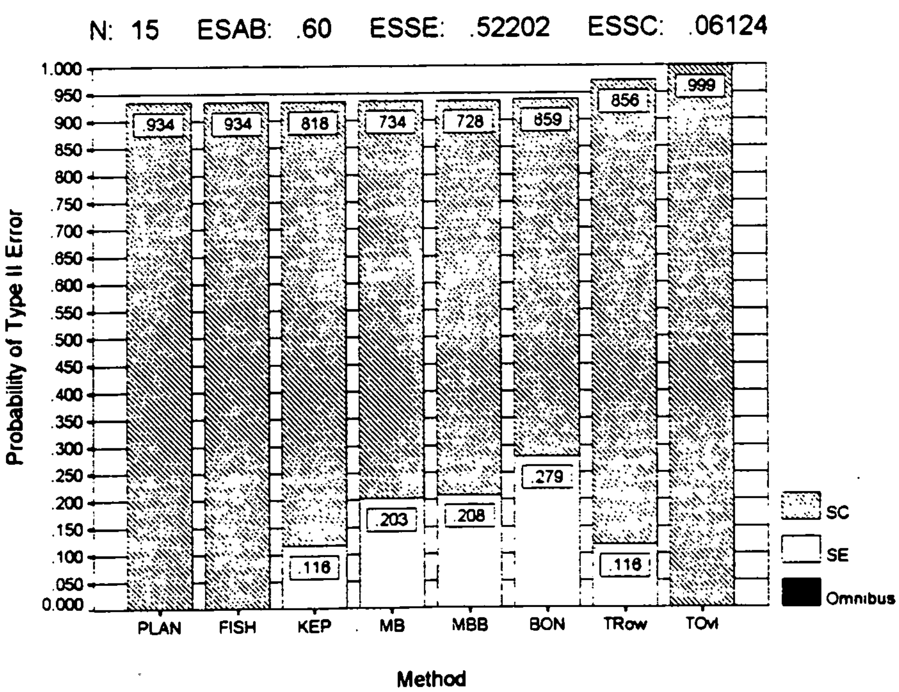
Omnibus


N: 15 ESAB: .60 ESSE: .52202 ESSC: .06124
Probability of Type II Error
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.200
.150
.100
.050
0.000
.934
.934
.818
.734
.728
.859
.856
.999
.116
.203
.208
.279
.116
PLAN
FISH
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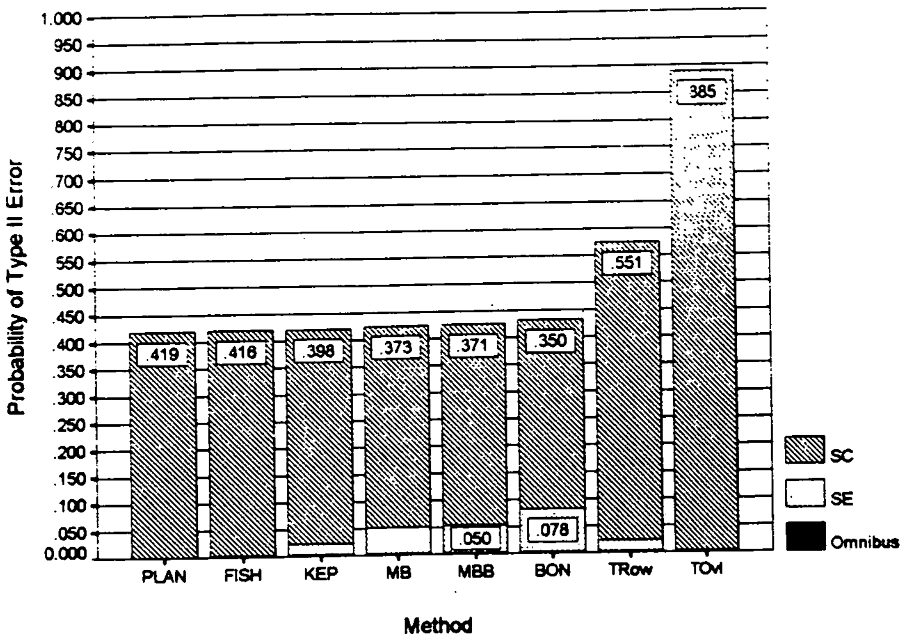
BON
TRow
TOM
Method
SC
SE
Omnibus

N: 15 ESAB: .40 ESSE: .65000 ESSC: .39804



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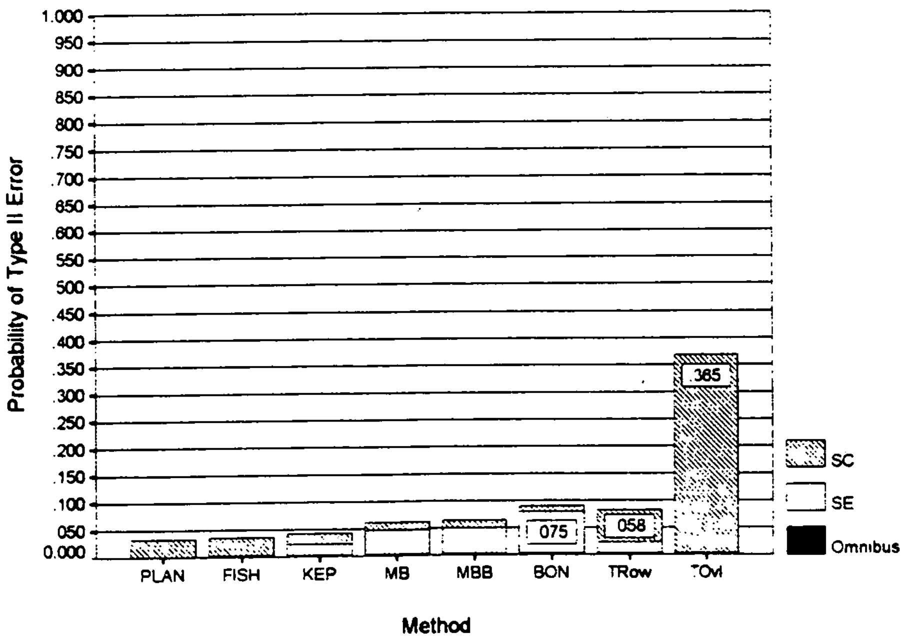

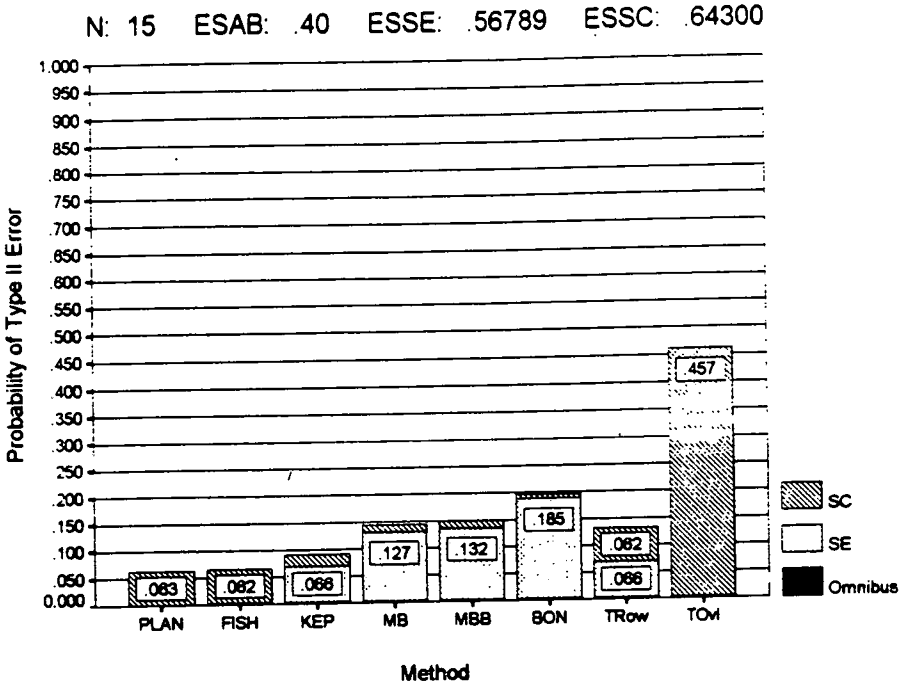
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0.000
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TRow
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Method
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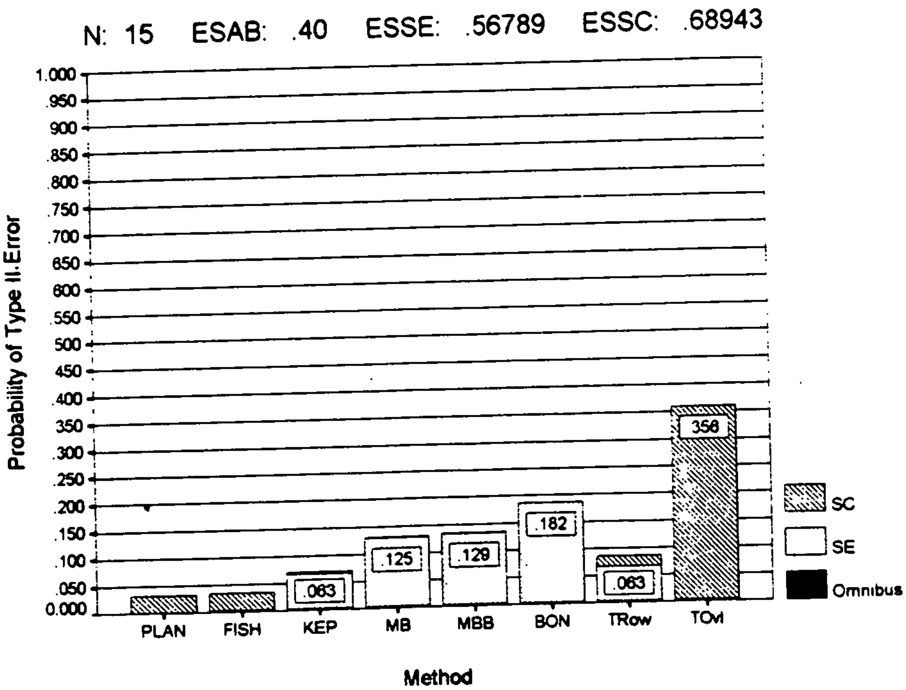
Omnibus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Probability of Type II Error
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TOVI
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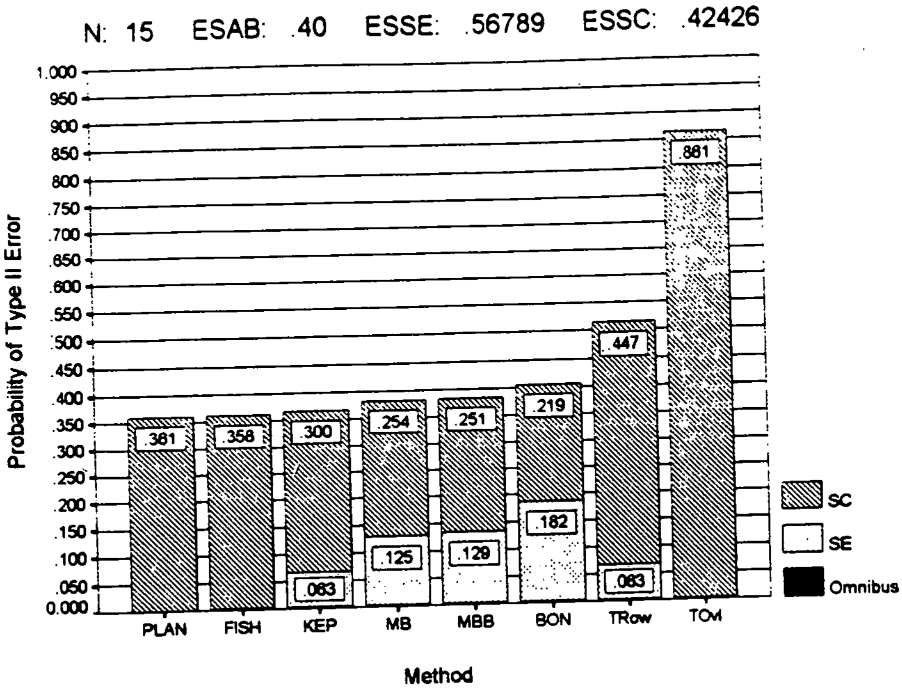
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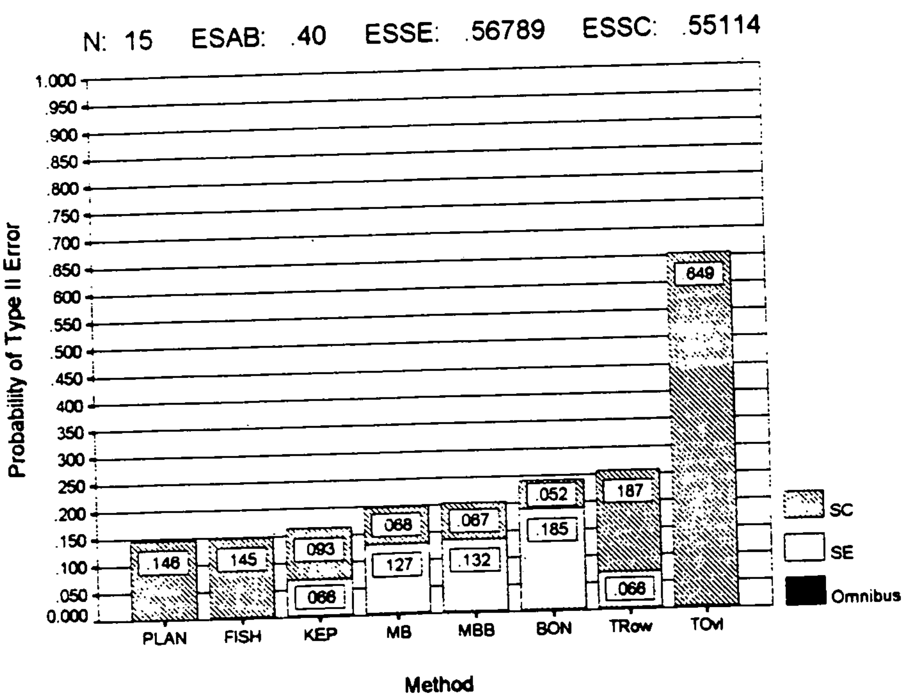
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.200
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.050
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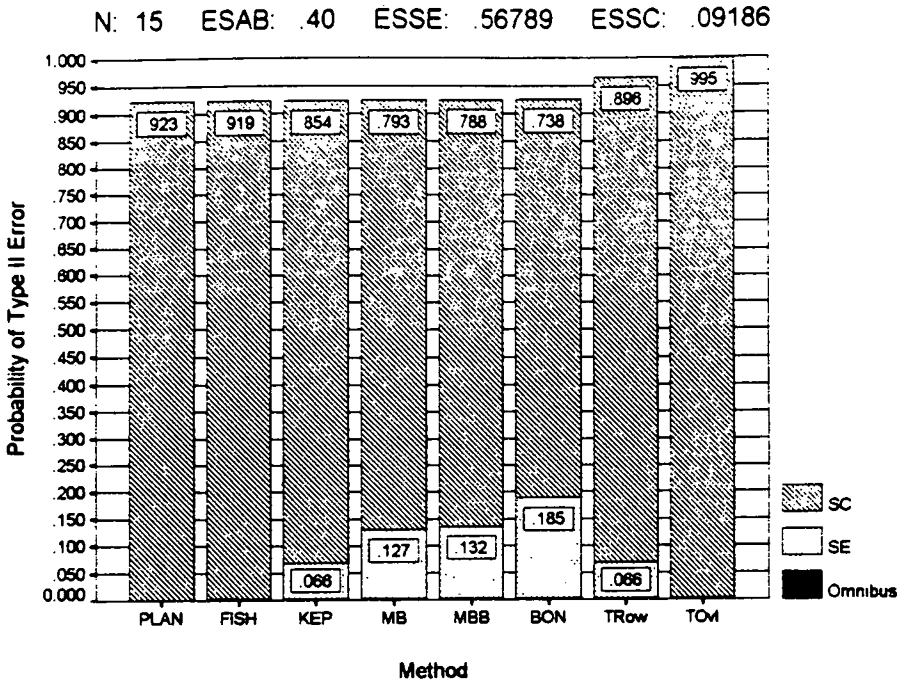
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Method
SC
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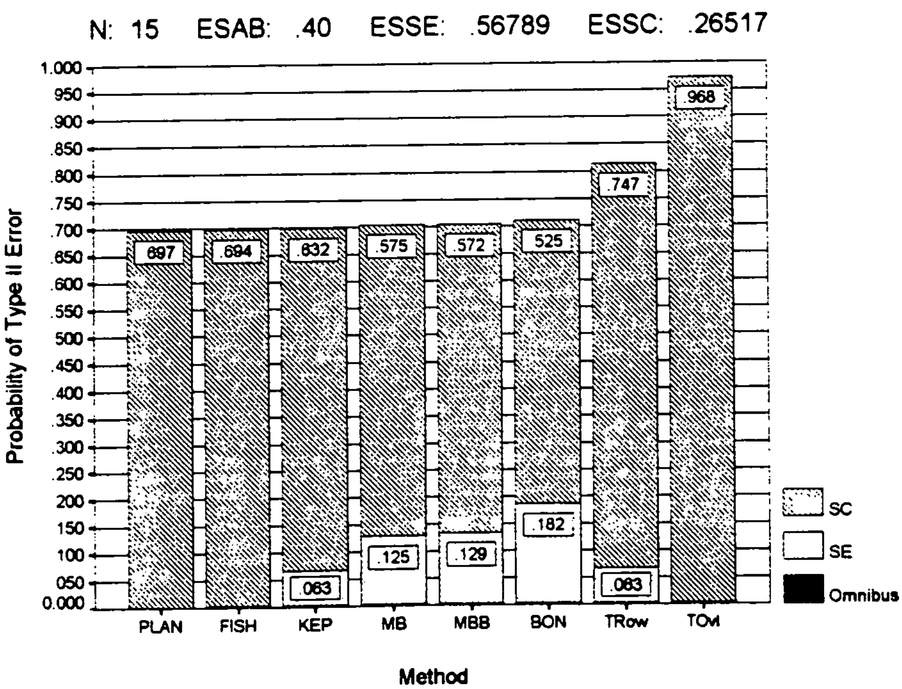
Omnibus


N: 15 ESAB: .40 ESSE: .56789 ESSC: .26517
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0.000
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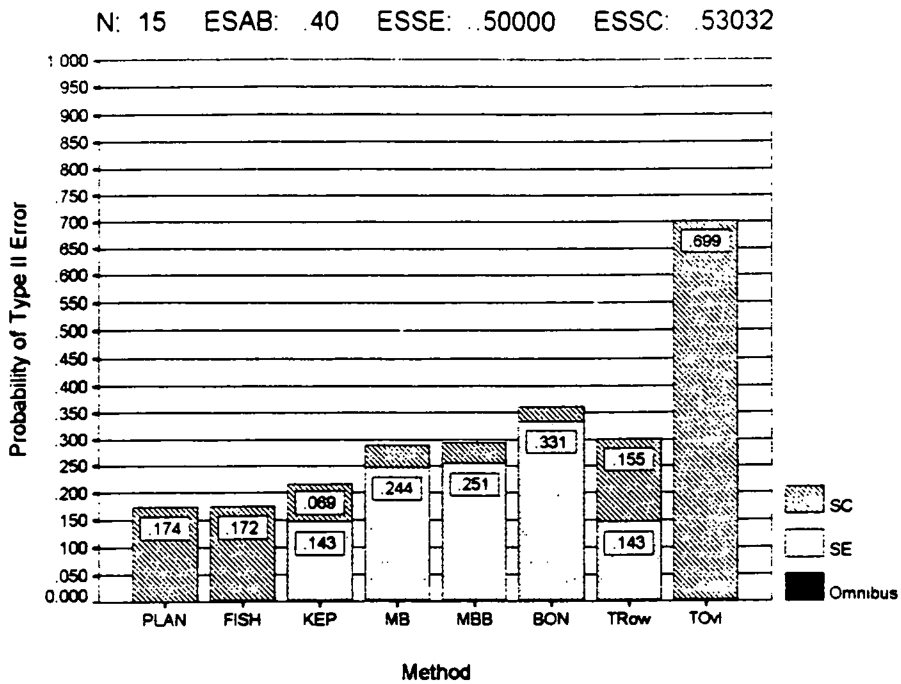
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Probability of Type II Error
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250
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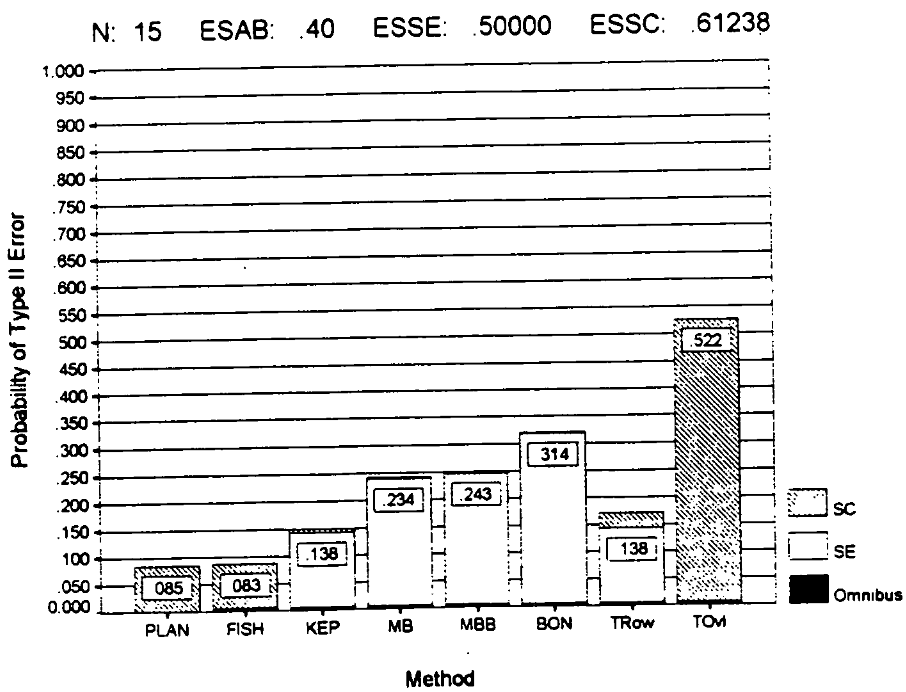
TOM
Method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Probability of Type II Error
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085
083
.138
.234
.243
314
138
.522
SC
SE
Omnibus
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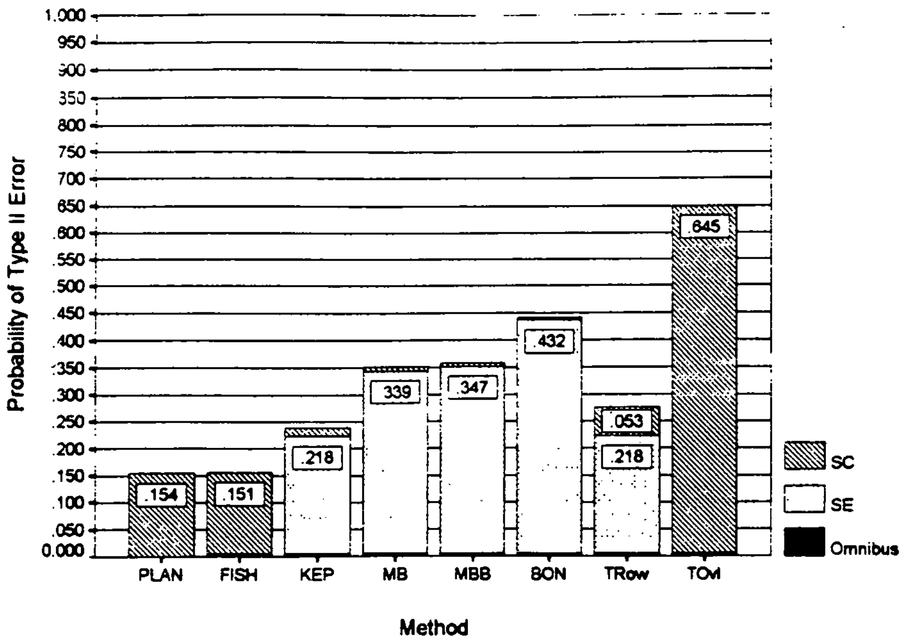
KEP
MB
MBB
BON
TRow
TOM
Method

N: 15 ESAB: .40 ESSE: .45826 ESSC: .55114



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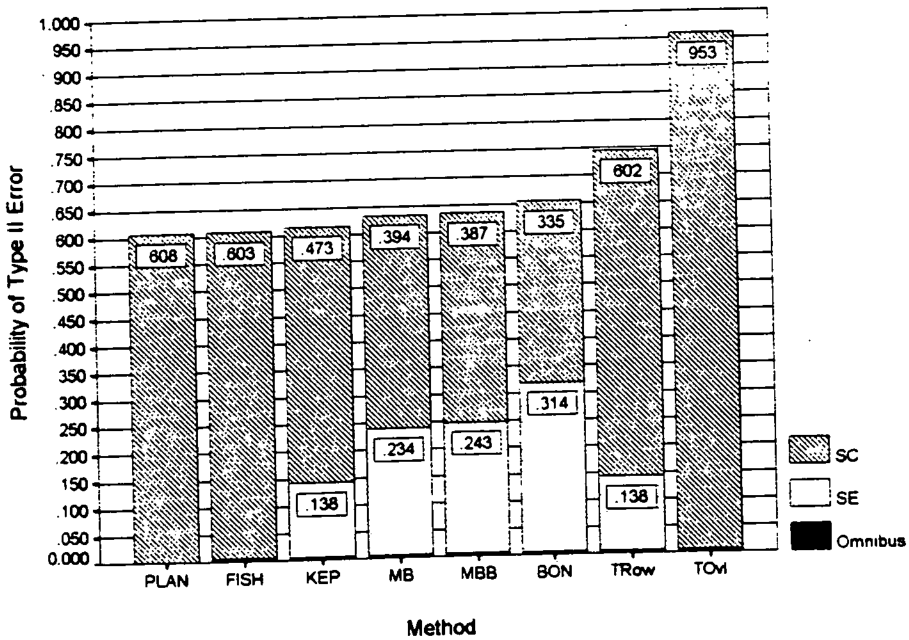

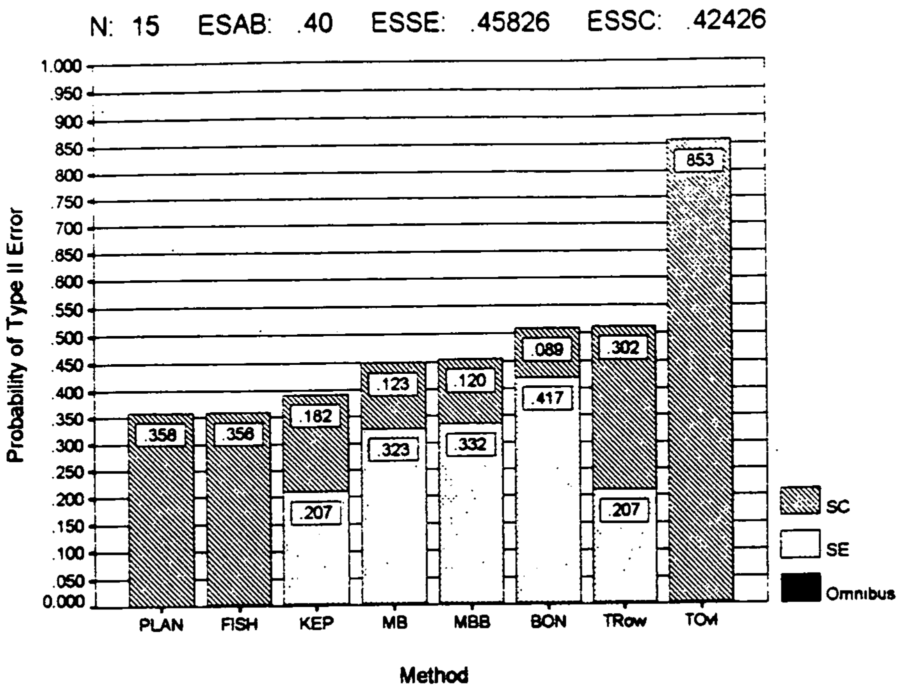
N: 15 ESAB: .40 ESSE: .45826 ESSC: .42426
Probability of Type II Error
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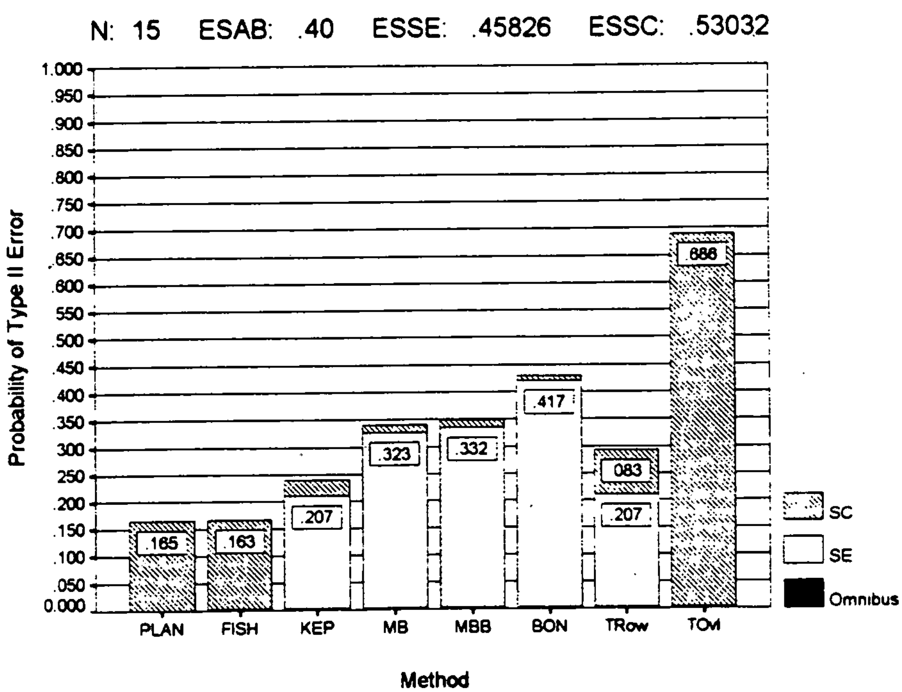
TRow
TOM
Method


N: 15 ESAB: .40 ESSE: .45826 ESSC: .53032
Probability of Type II Error
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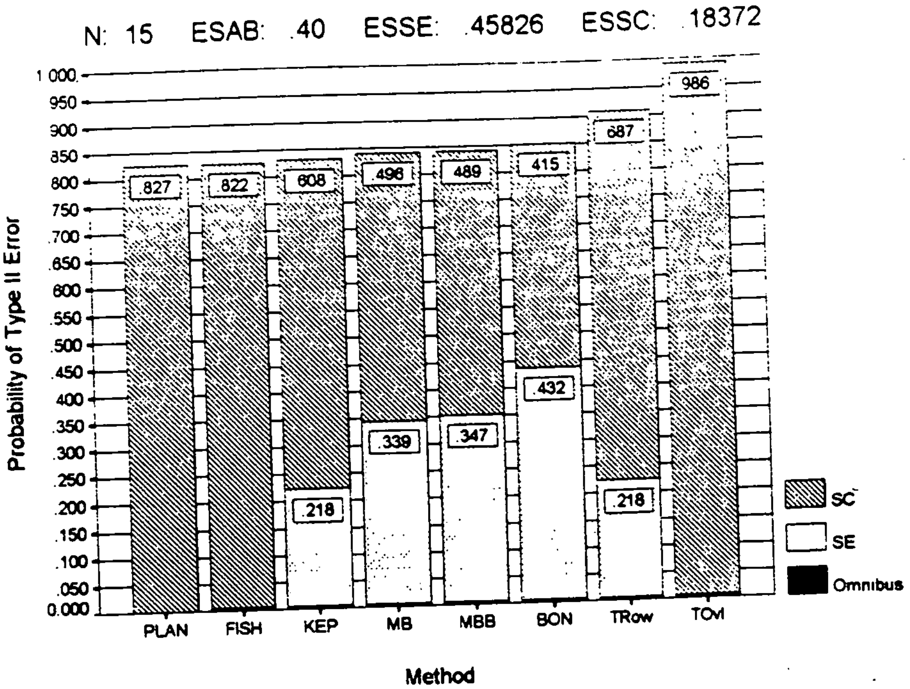
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.165
.163
.207
.323
.332
.417
.083
.207
.686
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method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Probability of Type II Error
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800
750
.700
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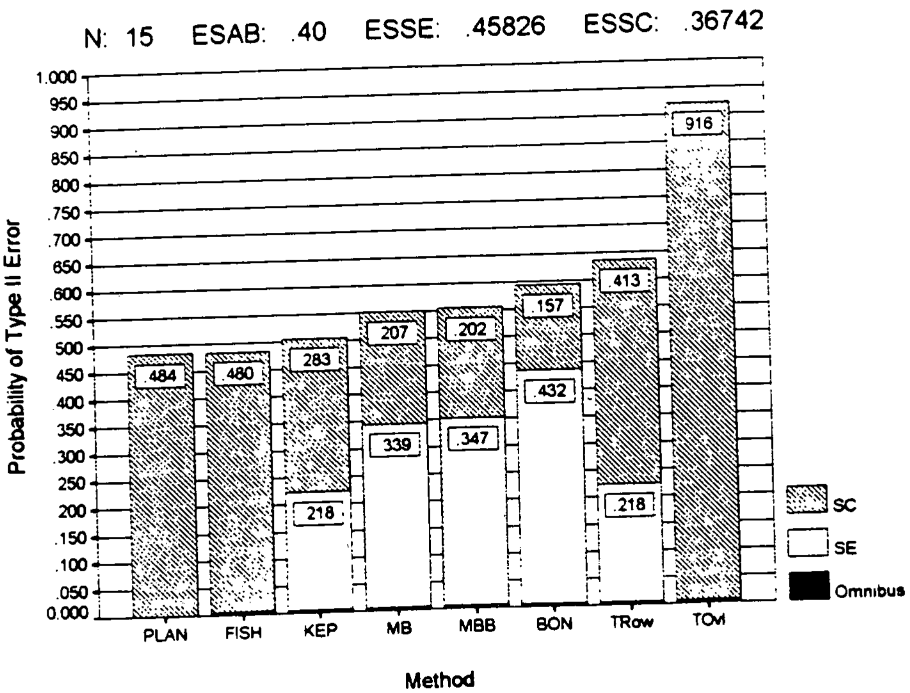
600
.550
.500
.450
400
.350
.300
.250
.200
.150
.100
.050
0.000
.827
.822
608
.496
489
415
.432
.339
.347
.218
687
.218
986
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method


N: 15 ESAB: .40 ESSE: .45826 ESSC: .36742
Probability of Type II Error
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950
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800
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650
.600
.550
500
450
.400
350
.300
250
200
.150
.100
.050
0.000
.484
.480
283
.218
207
339
.202
.347
.157
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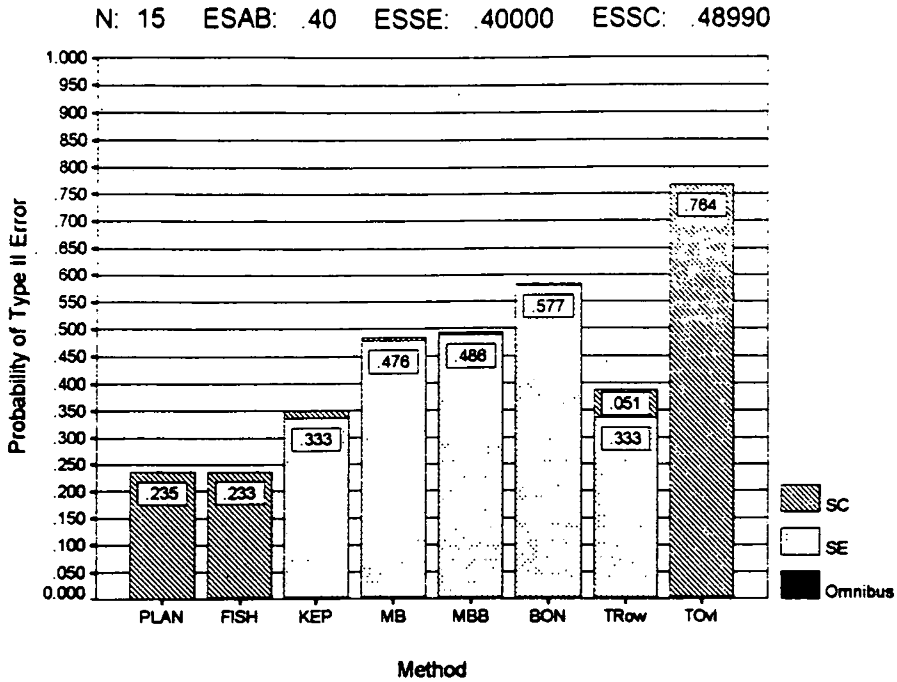
.218
916
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method


N: 15 ESAB: .40 ESSE: .40000 ESSC: .48990
Probability of Type II Error
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.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.235
.233
.333
.476
.486
.577
.051
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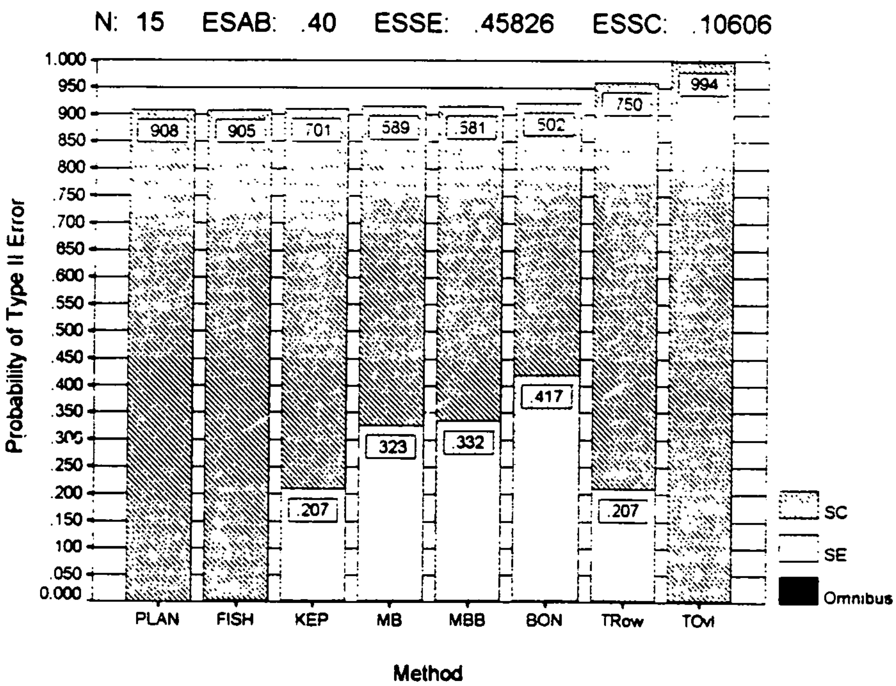
.764
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .45826 ESSC: .10606
Probability of Type II Error
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.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.908
.905
.701
.589
.581
.502
.750
.994
.207
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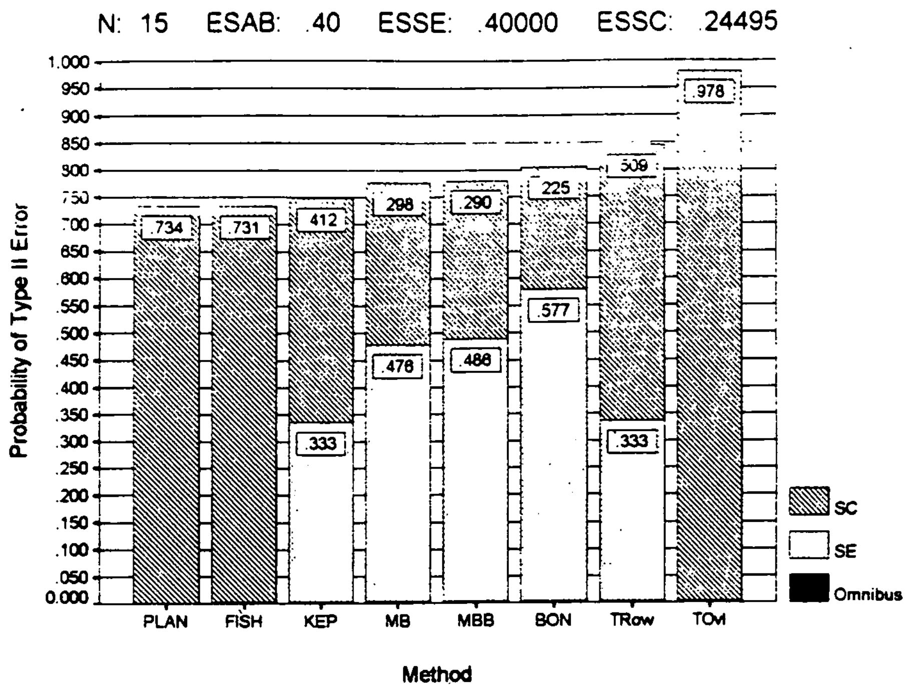
.207
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .40000 ESSC: .24495
Probability of Type II Error
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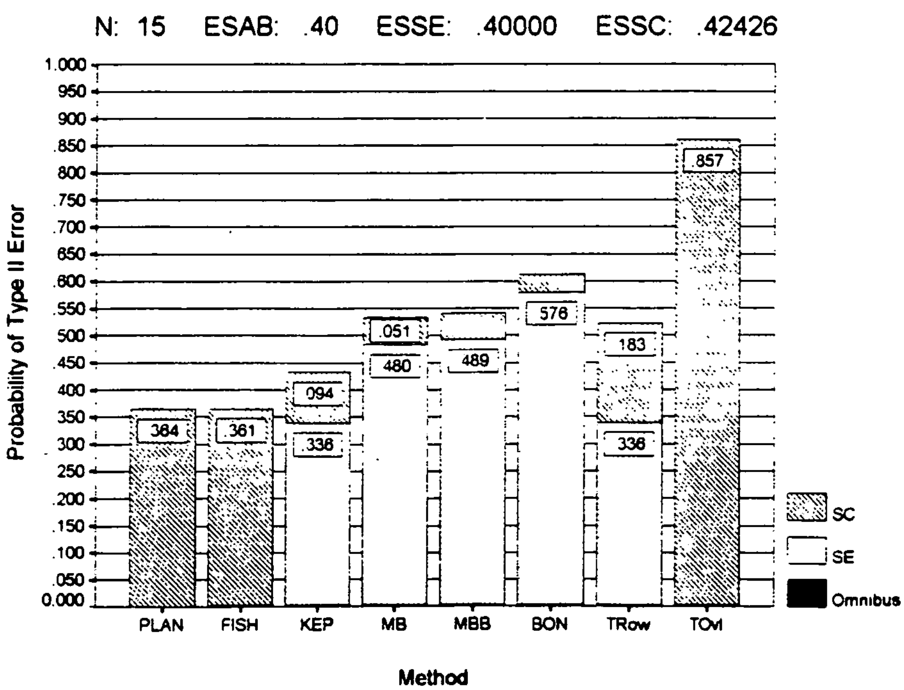
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.734
.731
.412
.333
.298
.478
.290
.488
.225
.577
.509
.333
.978
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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Probability of Type II Error
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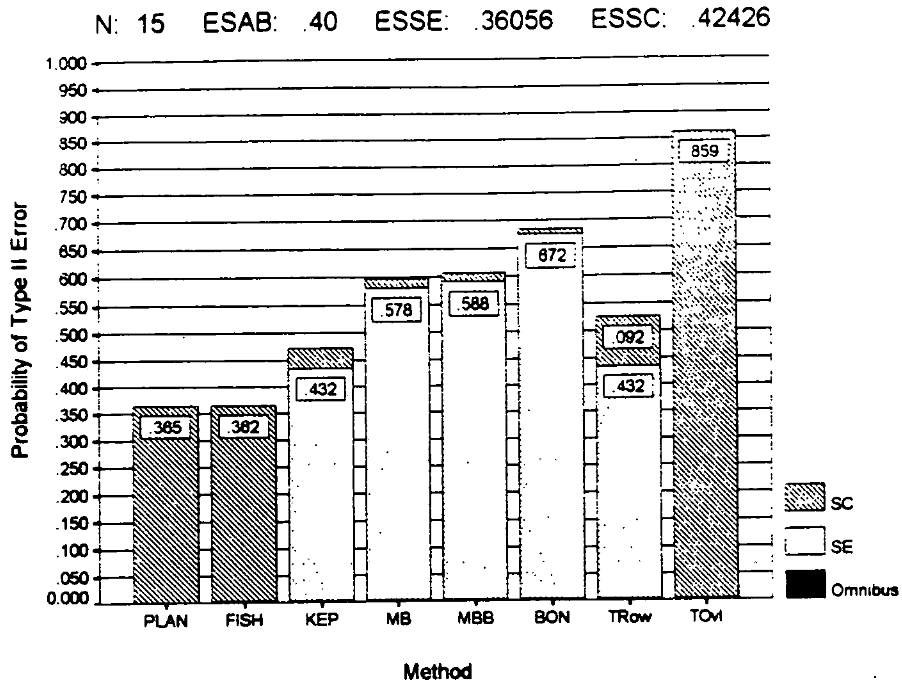
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.364
.361
.094
.336
.051
.480
.489
.576
.183
.336
.857
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .36056 ESSC: .42426
Probability of Type II Error
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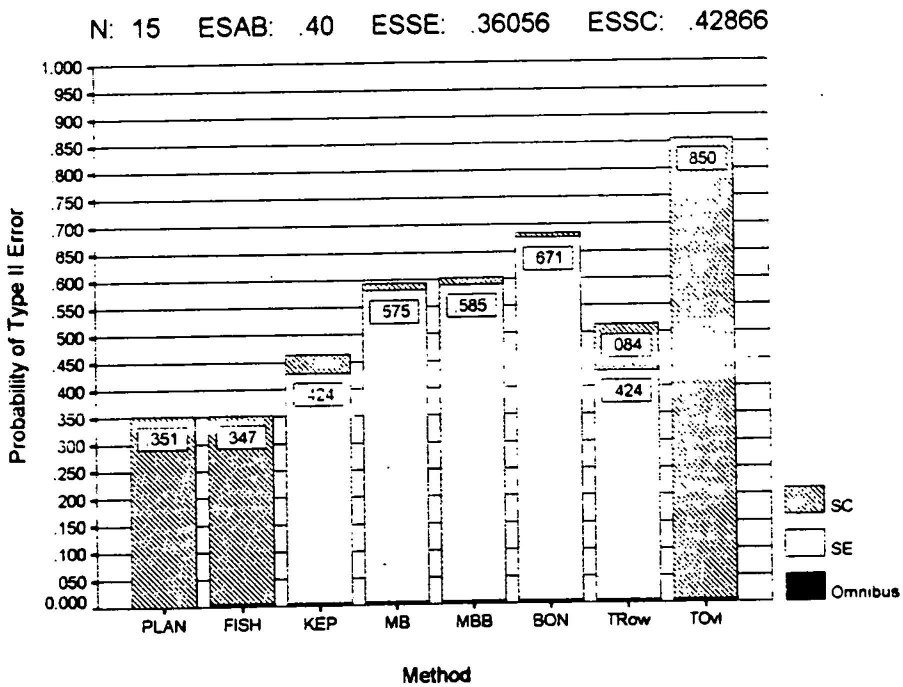
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.365
.362
.432
.578
.588
.672
.092
.432
.859
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .36056 ESSC: .42866
Probability of Type II Error
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.950
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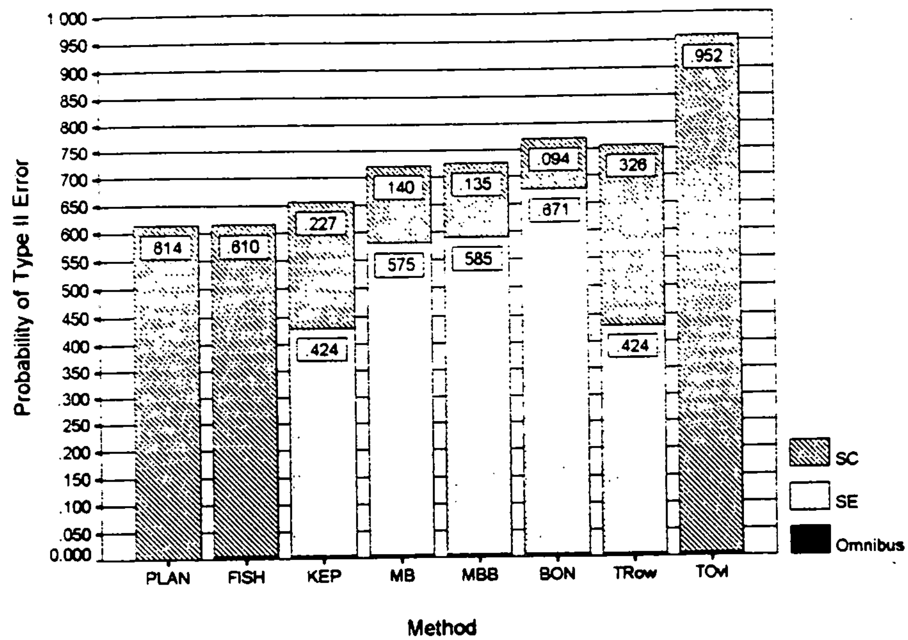
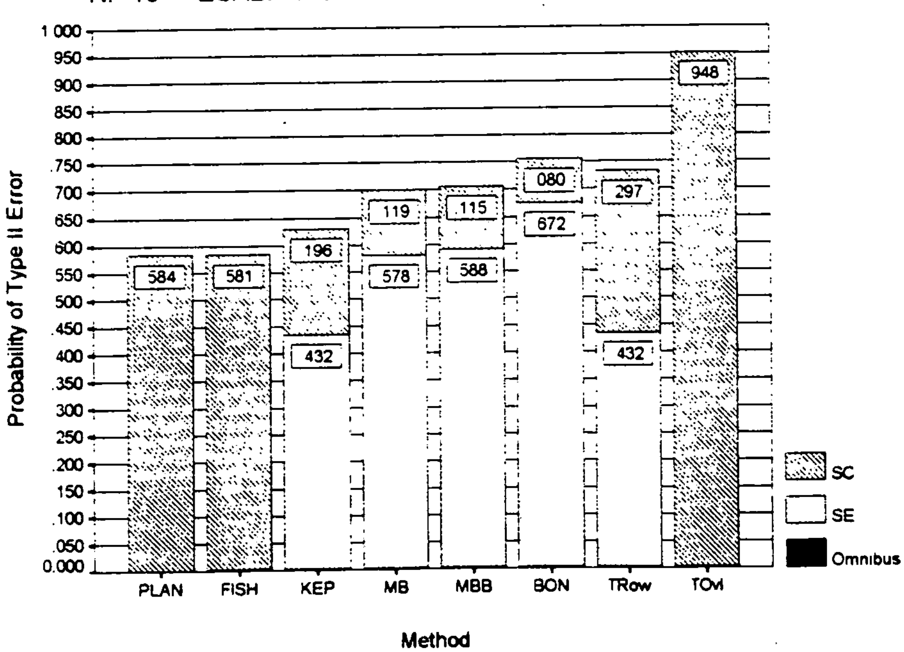
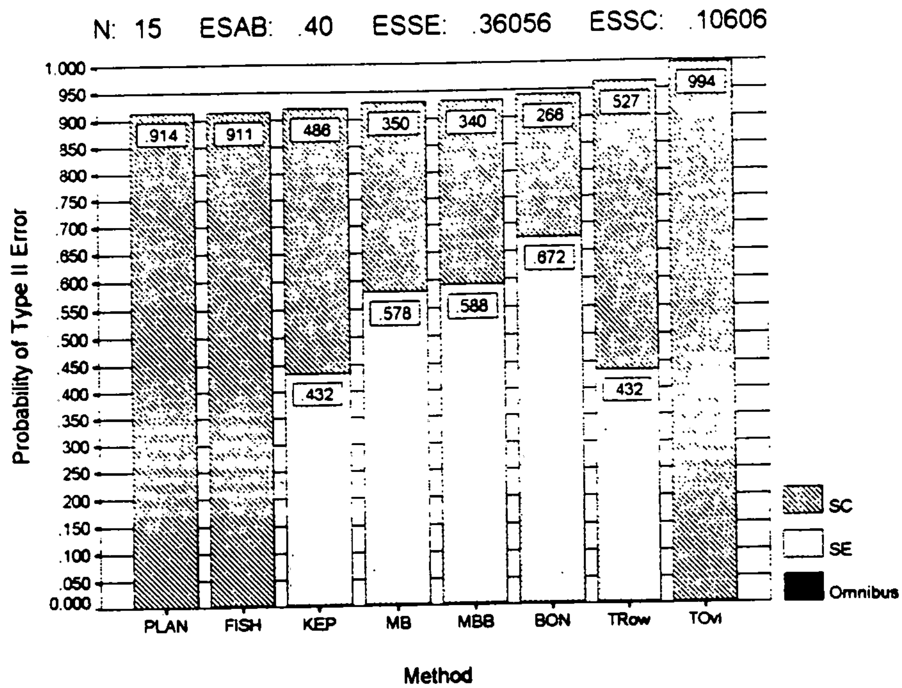
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.351
.347
.424
.575
.585
.671
.084
.424
.850
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus

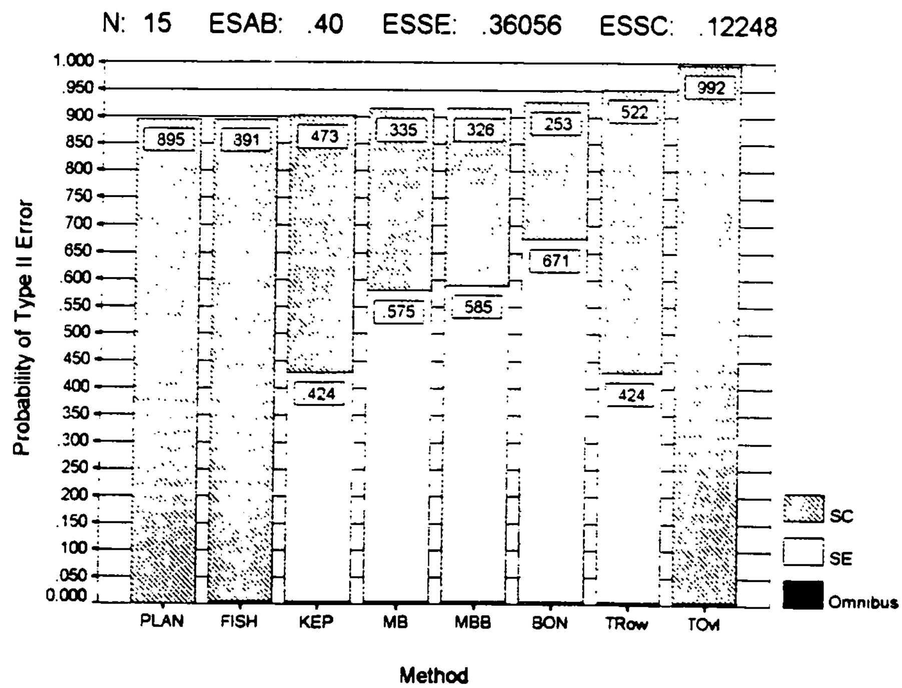
N: 15. ESAB: .40 ESSE: .36056 ESSC: .30619



N: 15 ESAB: .40 ESSE: .36056 ESSC: .31819




N: 15 ESAB: .40 ESSE: .36056 ESSC: .10606
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .36056 ESSC: .12248
Probability of Type II Error
Method
PLAN
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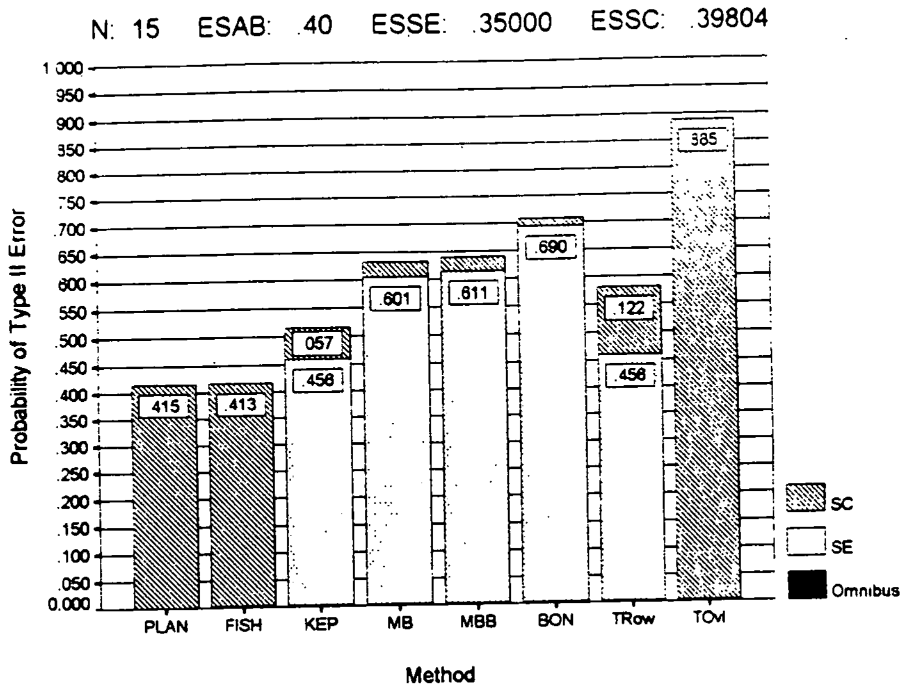
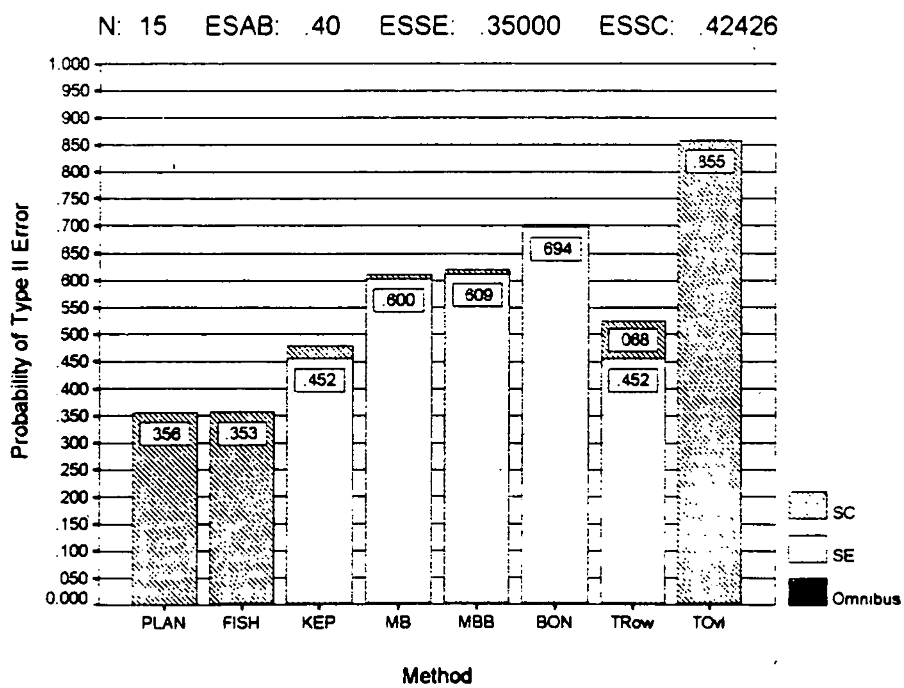
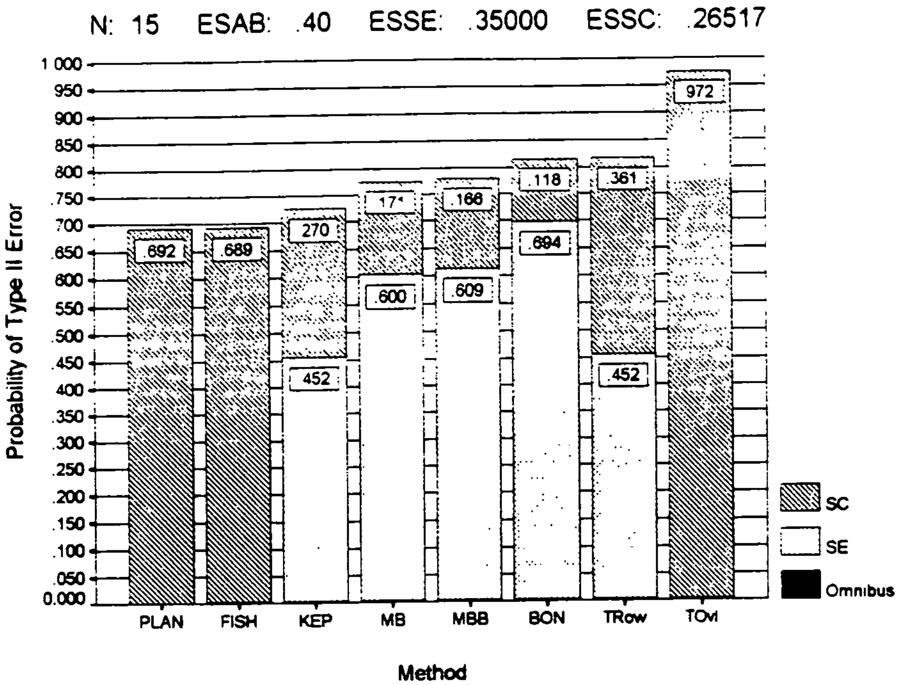
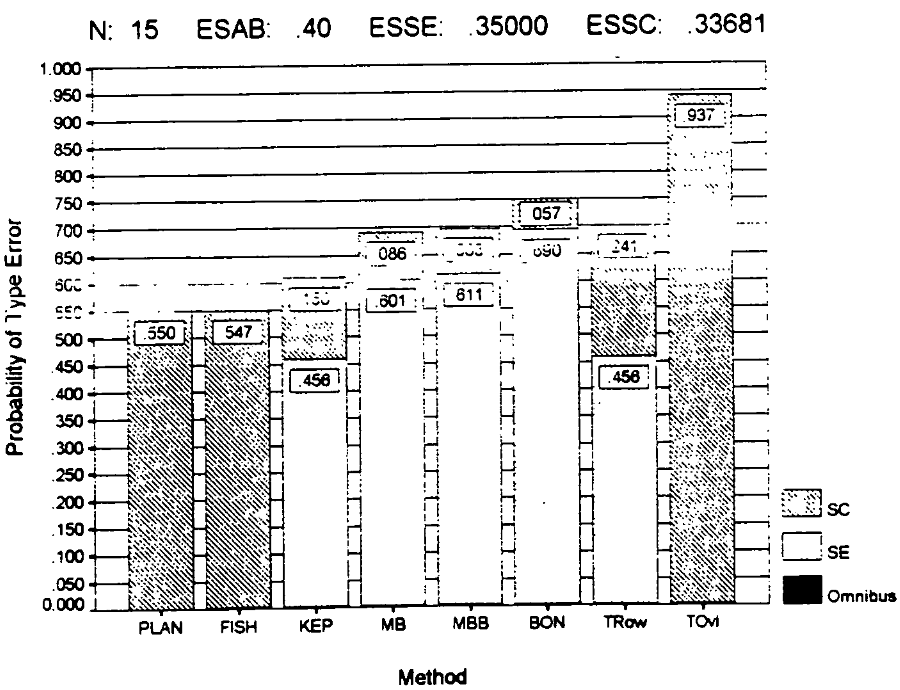
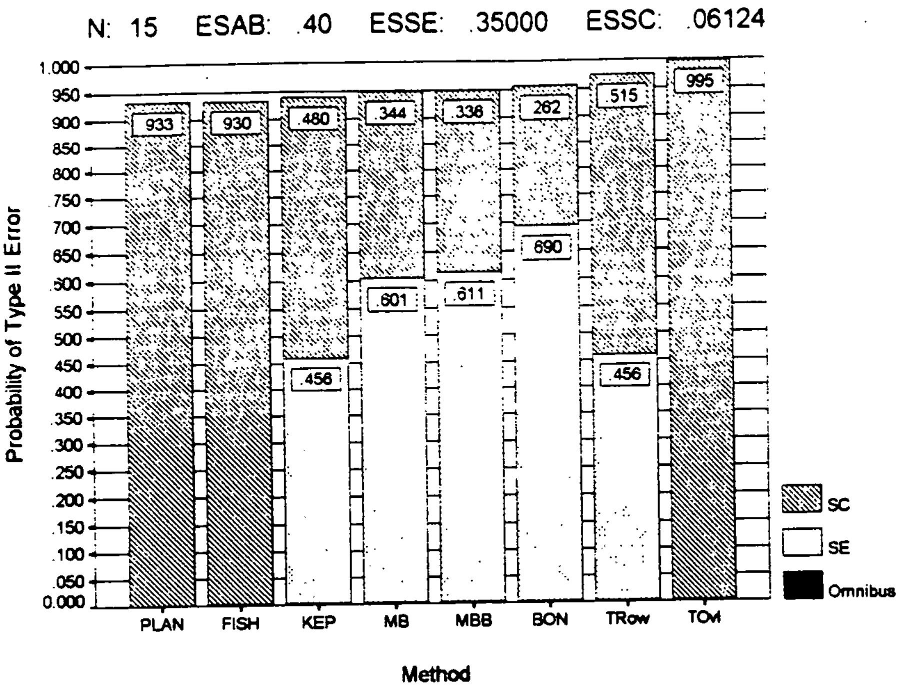
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus

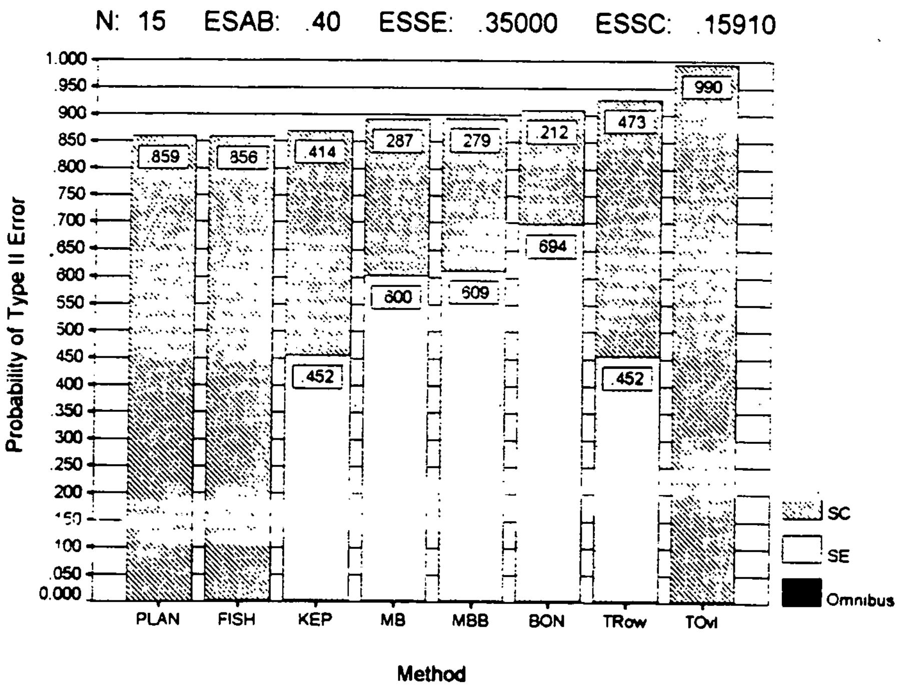

N: 15 ESAB: .40 ESSE: .35000 ESSC: .39804
Probability of Type II Error
415
413
.057
.456
.601
.611
.690
.122
.456
.385
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method

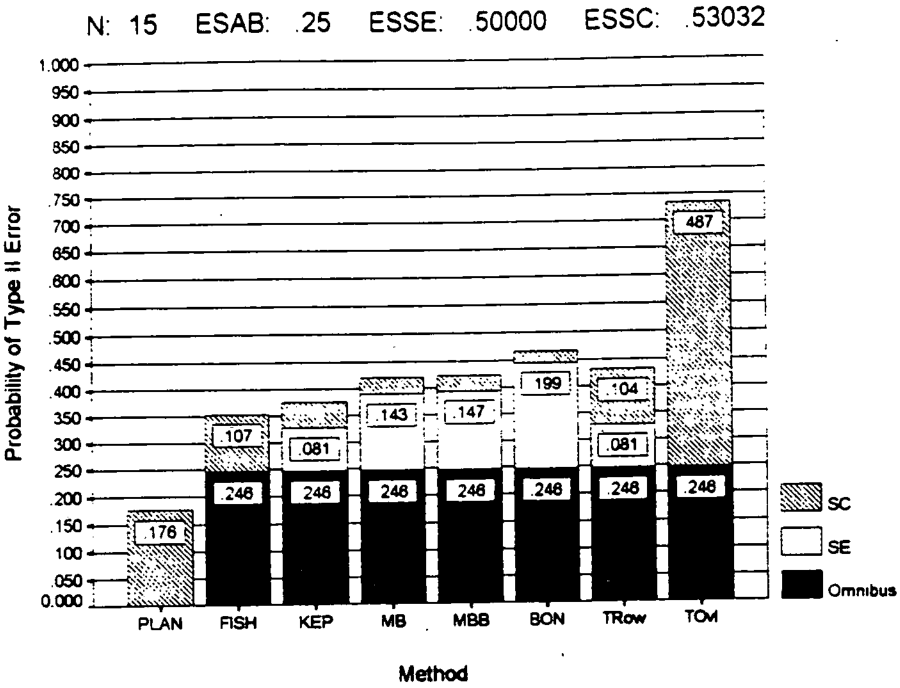

N: 15 ESAB: .40 ESSE: .35000 ESSC: .42426
Probability of Type II Error
.356
.353
.452
.600
.609
.694
.068
.452
.355
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method


N: 15 ESAB: .40 ESSE: .35000 ESSC: .26517
Probability of Type II Error
.692
.689
.270
.452
.600
.609
.166
.118
.694
.361
.452
.972
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .35000 ESSC: .33681
Probability of Type Error
.550
.547
.456
.601
.086
.611
.057
.241
.456
.937
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .35000 ESSC: .06124
Probability of Type II Error
.933
.930
.480
.456
.344
.601
.338
.611
.262
.690
.515
.456
.995
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .40 ESSE: .35000 ESSC: .15910
Probability of Type II Error
.859
.856
.414
.452
.287
.600
.279
.609
.212
.694
.473
.452
.990
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .25 ESSE: .50000 ESSC: .53032
Probability of Type II Error
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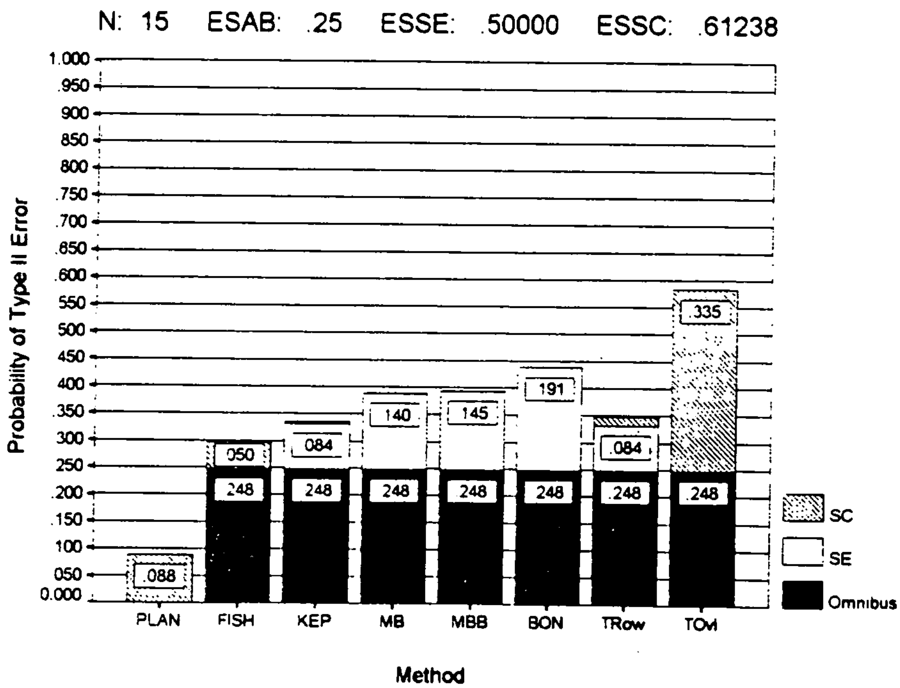
900
850
800
.750
700
650
.600
.550
.500
.450
.400
350
300
250
.200
.150
100
.050
0.000
.176
.107
.248
.081
.143
.147
199
104
487
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method


N: 15 ESAB: .25 ESSE: .50000 ESSC: .61238
Probability of Type II Error
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850
800
.750
.700
.650
.600
550
500
450
400
.350
300
250
.200
.150
100
050
0.000
.088
050
248
084
140
145
191
.084
.335
SC
SE
Omnibus
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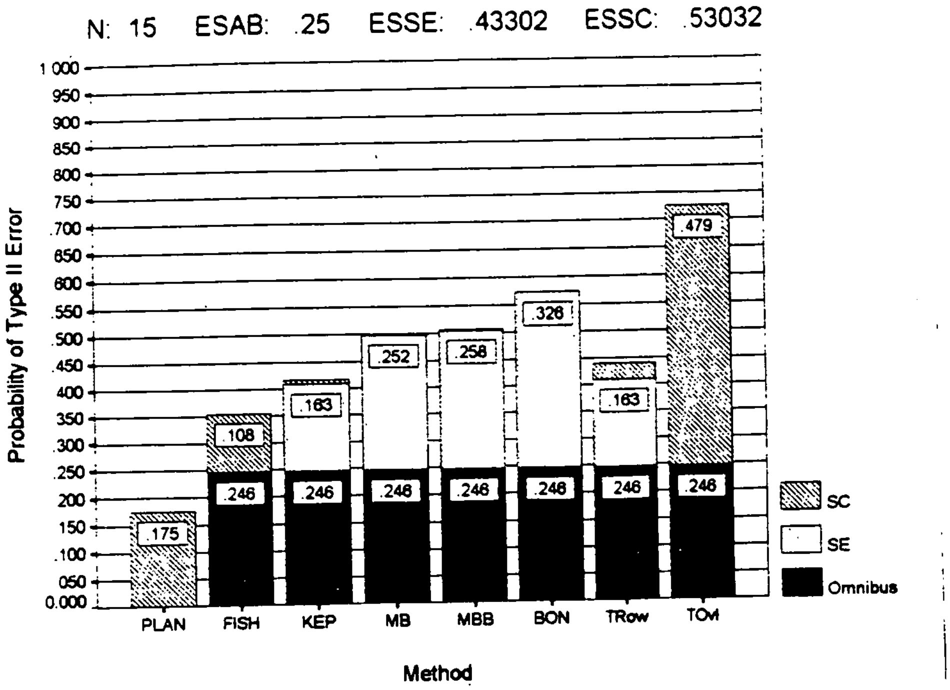
FISH
KEP
MB
MBB
BON
TRow
TCM
Method


N: 15 ESAB: .25 ESSE: .43302 ESSC: .53032
Probability of Type II Error
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.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.175
.108
.163
.252
.258
.326
.163
.479
.246
.246
.246
.246
.246
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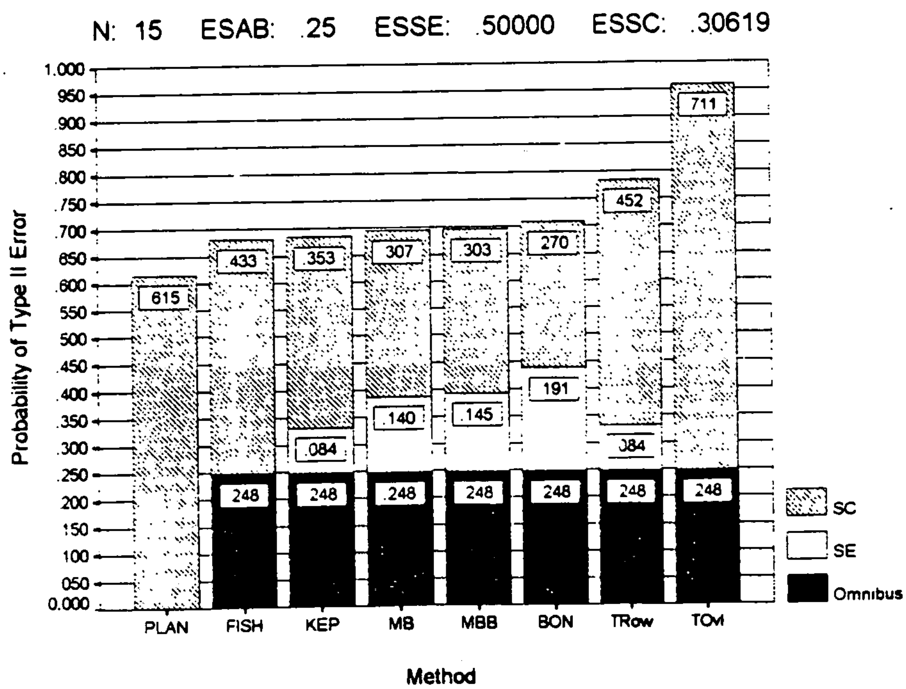
.246
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .25 ESSE: .50000 ESSC: .30619
Probability of Type II Error
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.950
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.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.615
.433
.353
.307
.303
.270
.452
.711
.084
.140
.145
.191
.084
.248
.248
.248
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PLAN
FISH
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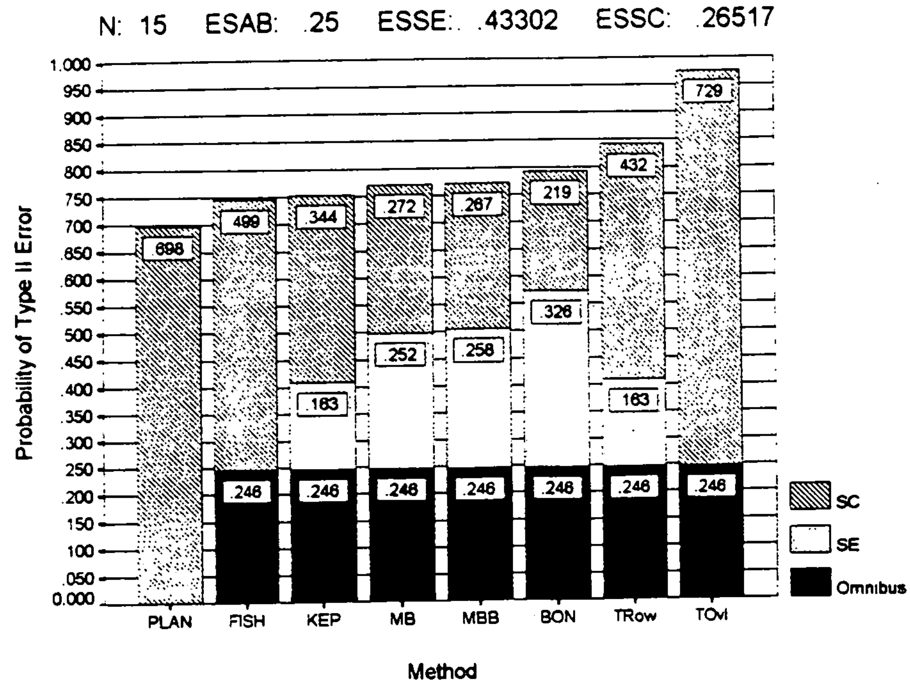
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 15 ESAB: .25 ESSE: .43302 ESSC: .26517
Probability of Type II Error
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.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
698
499
344
272
267
219
432
729
.163
.252
.258
.326
.163
.246
.246
.246
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PLAN
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KEP
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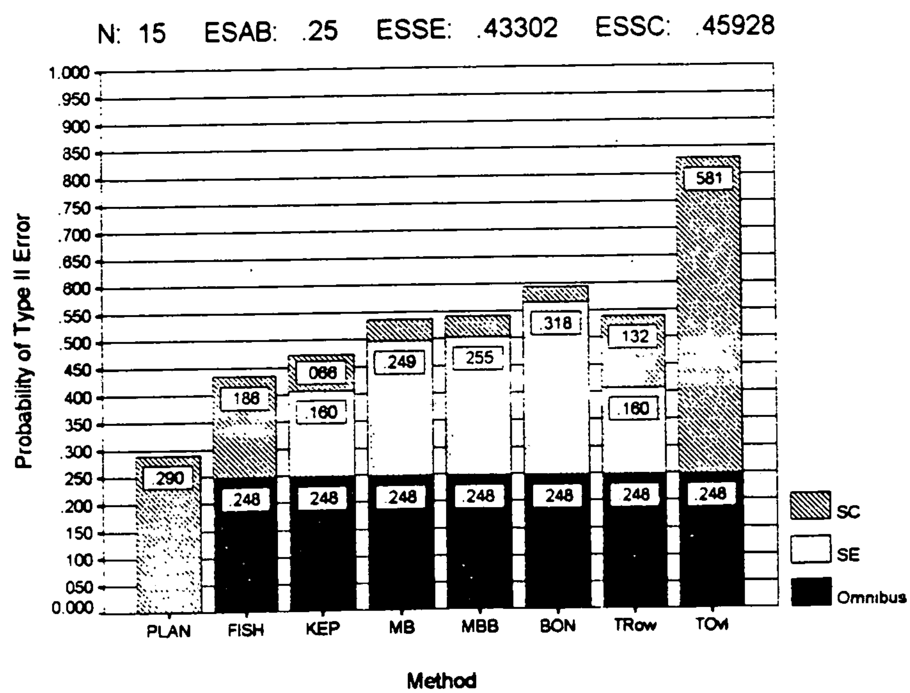
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 15 ESAB: .25 ESSE: .43302 ESSC: .45928
Probability of Type II Error
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.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
581
.318
132
.249
255
.066
188
.160
.160
.290
.248
.248
.248
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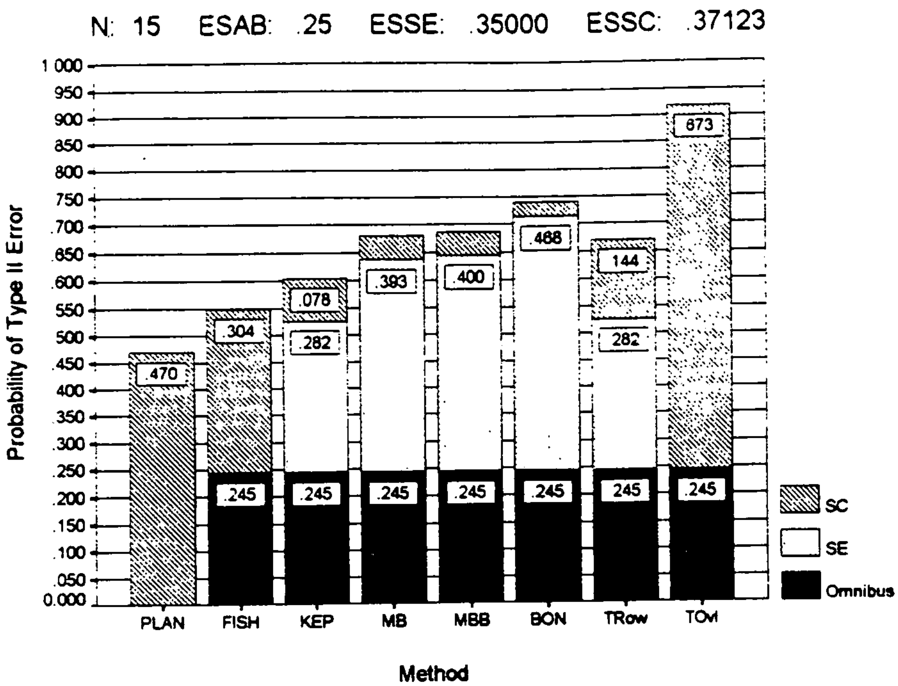
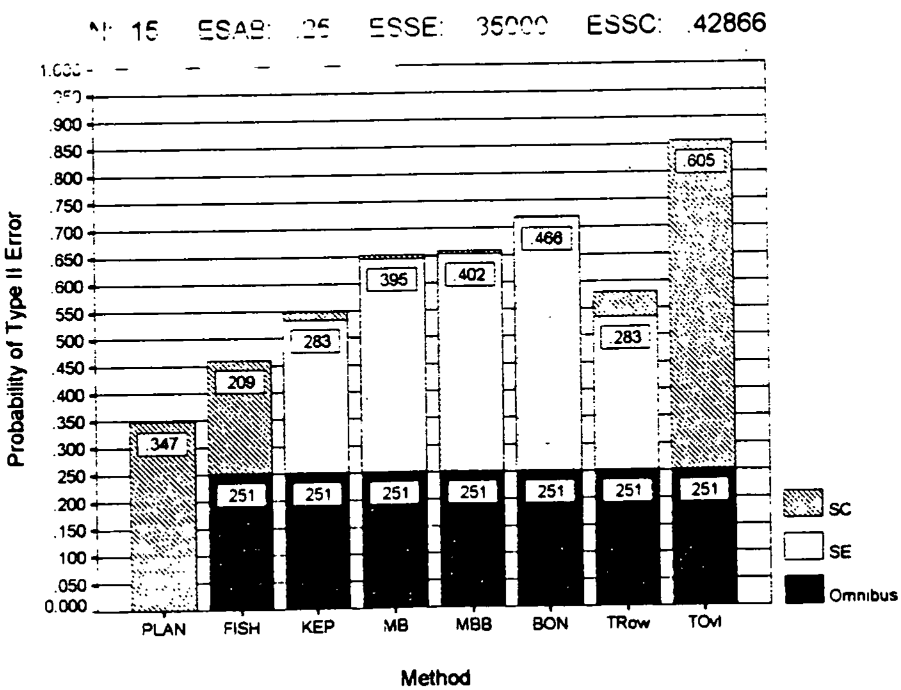
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 15 ESAB: .25 ESSE: .35000 ESSC: .37123
Probability of Type II Error
.470
.304
.245
.078
.282
.393
.400
.488
.144
.873
SC
SE
Omnibus
PLAN FISH KEP MB MBB BON TRow TCM
Method



ESSC: .42866
Probability of Type II Error
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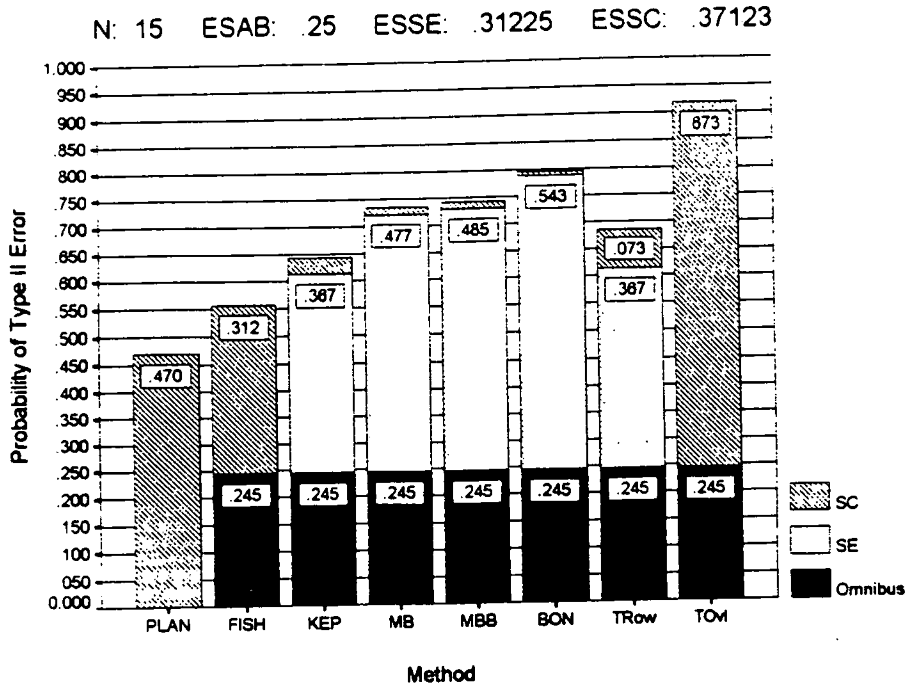
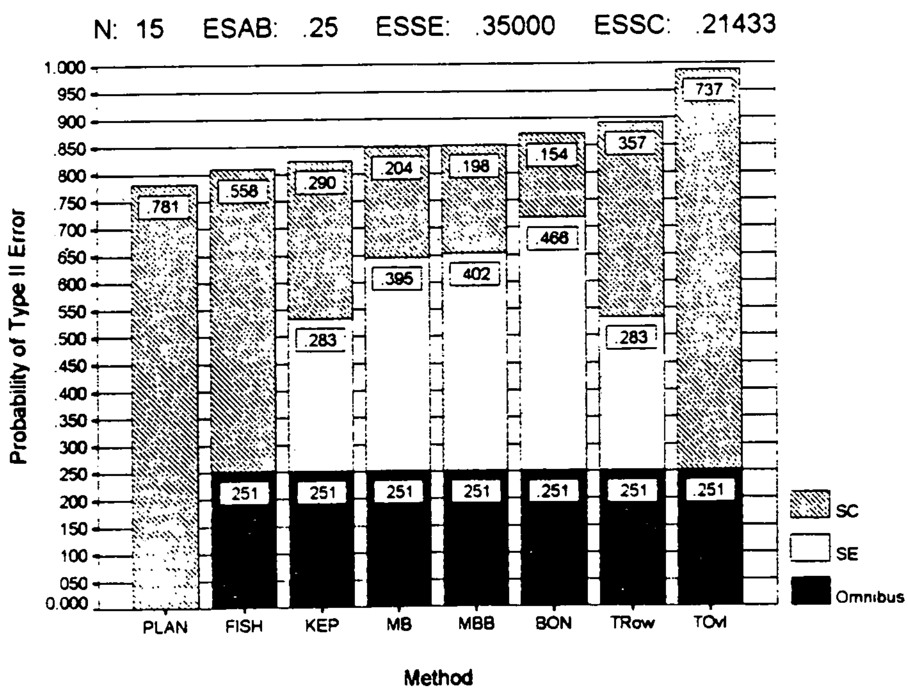
209
251
283
395
.402
.466
.283
.605
SC
SE
Omnibus
PLAN FISH KEP MB MBB BON TRow TCM
Method


N: 15 ESAB: .25 ESSE: .31225 ESSC: .37123
Probability of Type II Error
.470
.312
.387
.477
.485
.543
.073
.387
.873
.245
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method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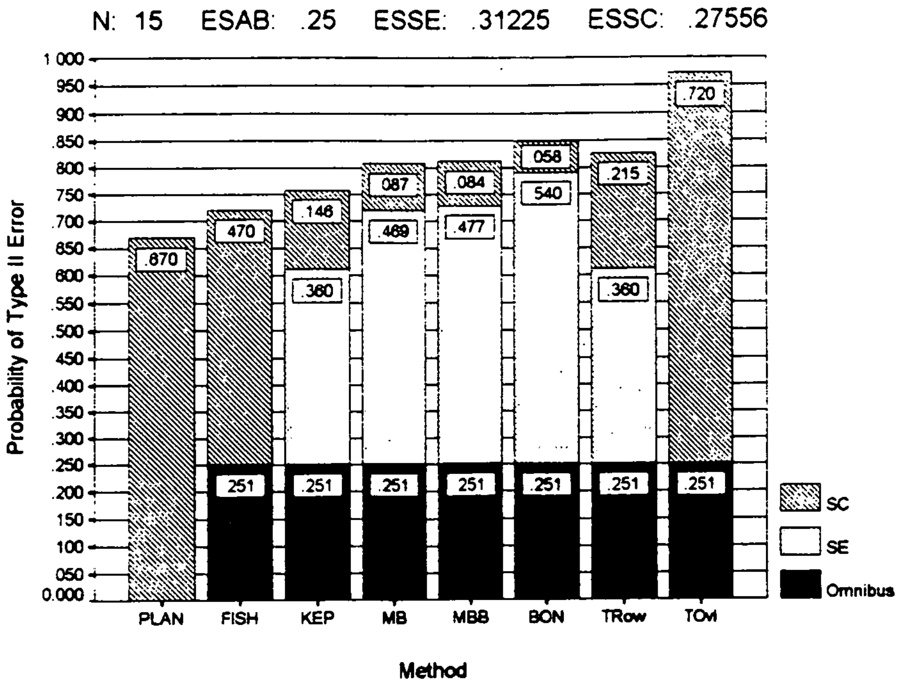
Probability of Type II Error
.781
.558
.290
.204
.198
.154
.357
.737
.283
.395
.402
.466
.283
.251
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method


N: 15 ESAB: .25 ESSE: .31225 ESSC: .27556
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
SC
SE
Omnibus
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.469
.084
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.058
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.360
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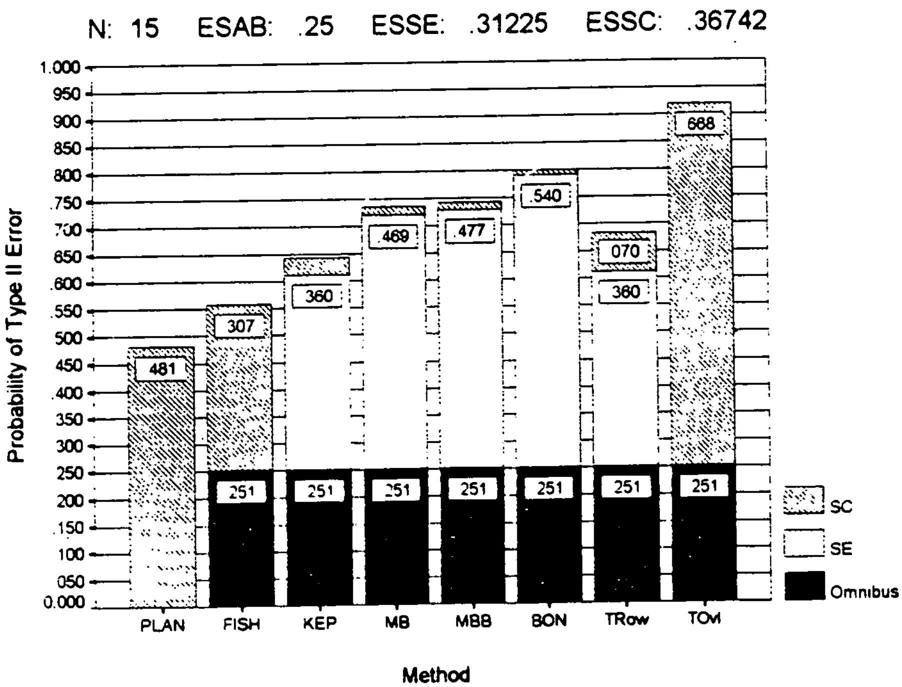
.251


N: 15 ESAB: .25 ESSE: .31225 ESSC: .36742
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
SC
SE
Omnibus
481
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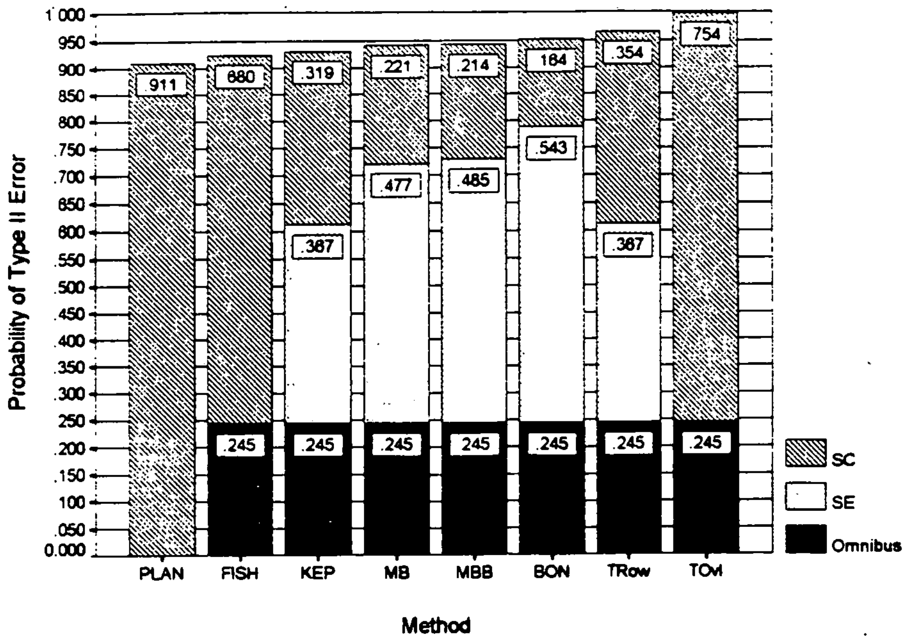
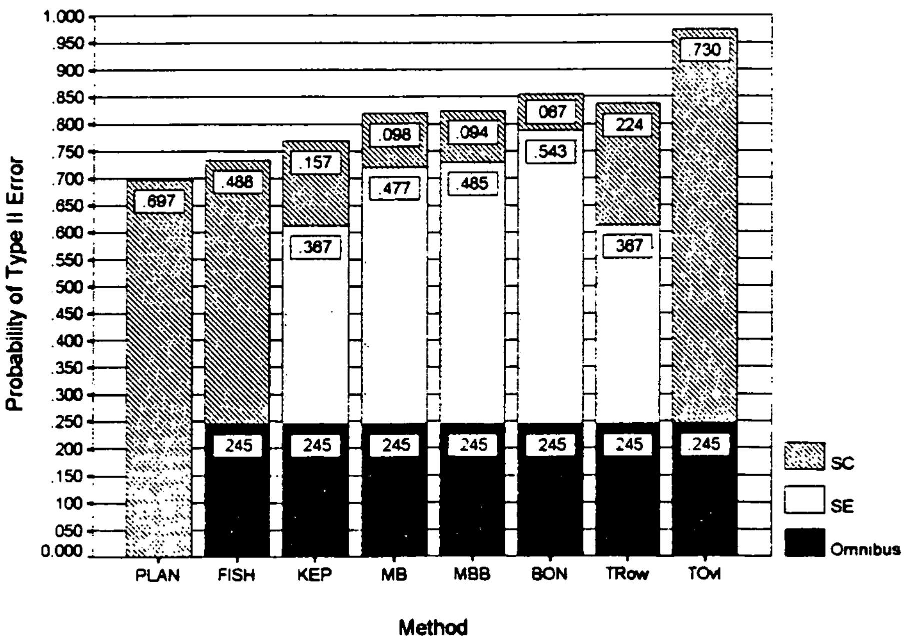
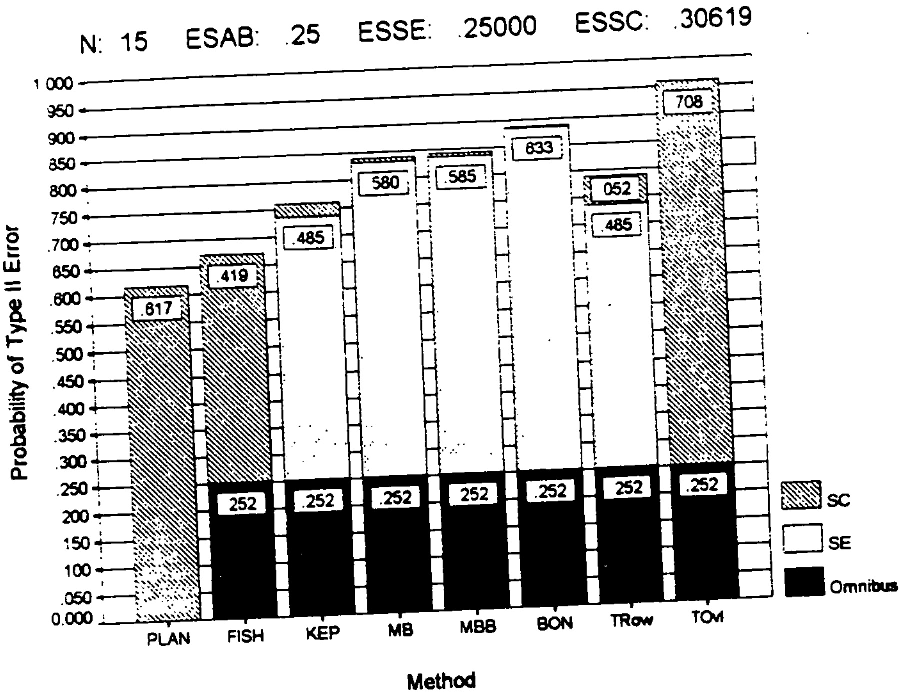
360
.469
.477
.540
070
360
668
251

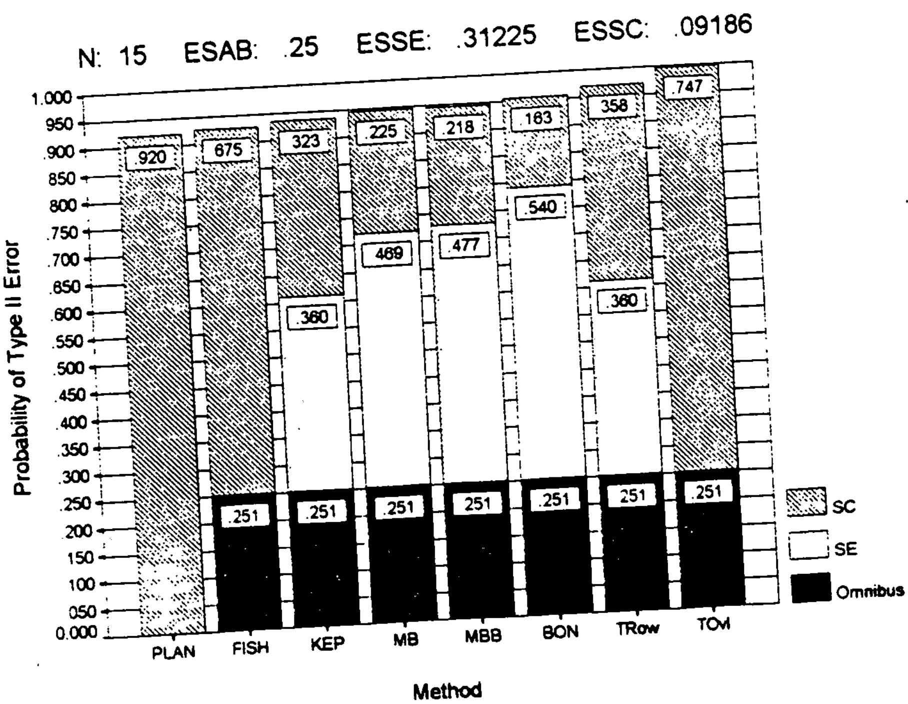
N: 15 ESAB: .25 ESSE: .31225 ESSC: .10606



N: 15 ESAB: .25 ESSE: .31225 ESSC: .26517




N: 15 ESAB: .25 ESSE: .25000 ESSC: .30619
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.617
.419
.485
.580
.585
.833
.052
.485
.708
.252
.252
.252
.252
.252
.252
.252
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .25 ESSE: .31225 ESSC: .09186
Probability of Type II Error
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.950
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.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.920
.675
.323
.225
.218
.163
.358
.747
.360
.469
.477
.540
.360
.251
.251
.251
.251
.251
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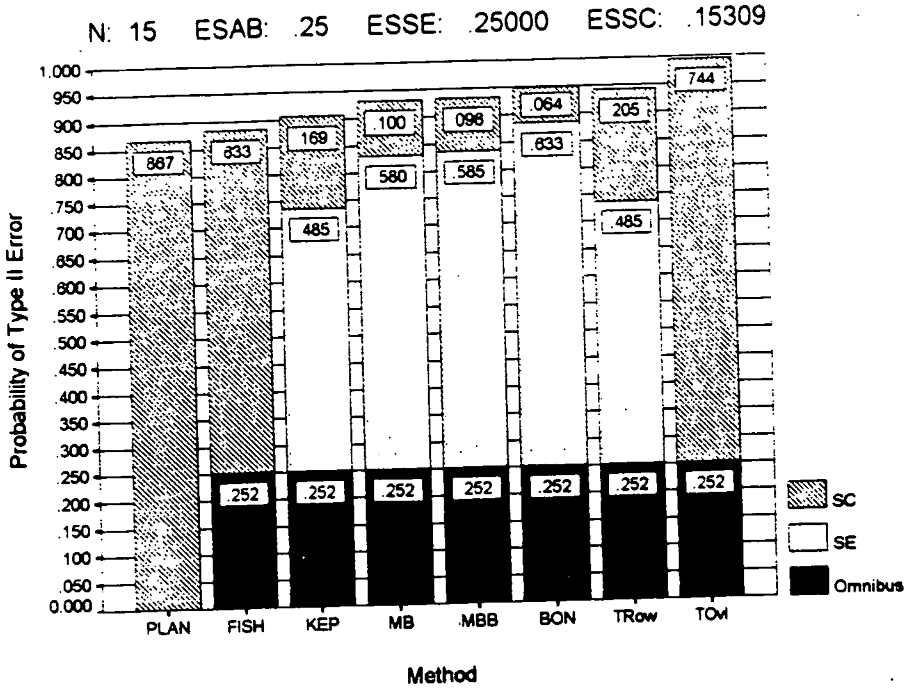
.251
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .25 ESSE: .25000 ESSC: .15309
Probability of Type II Error
1.000
.950
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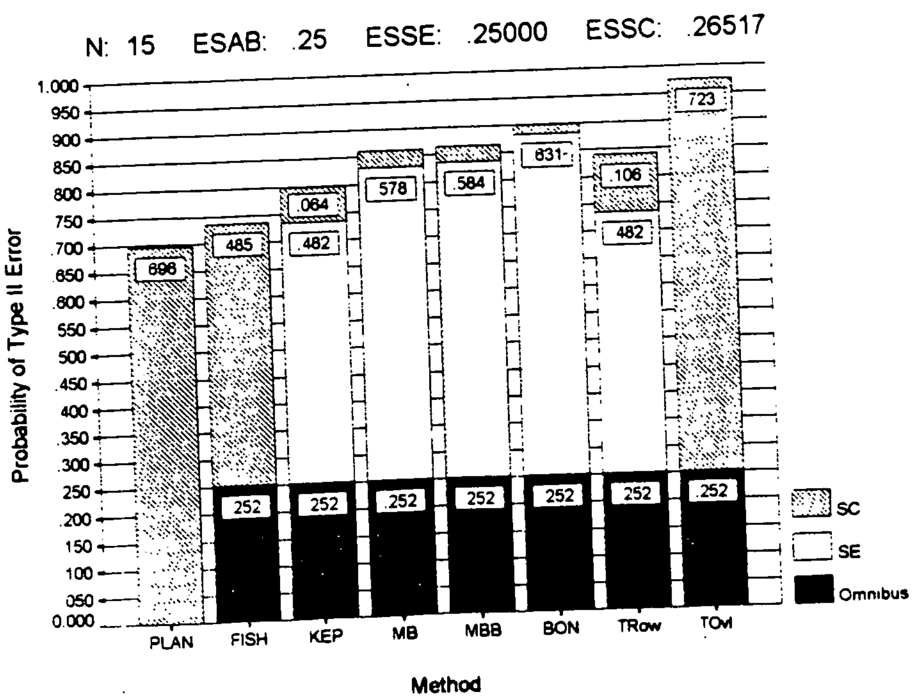
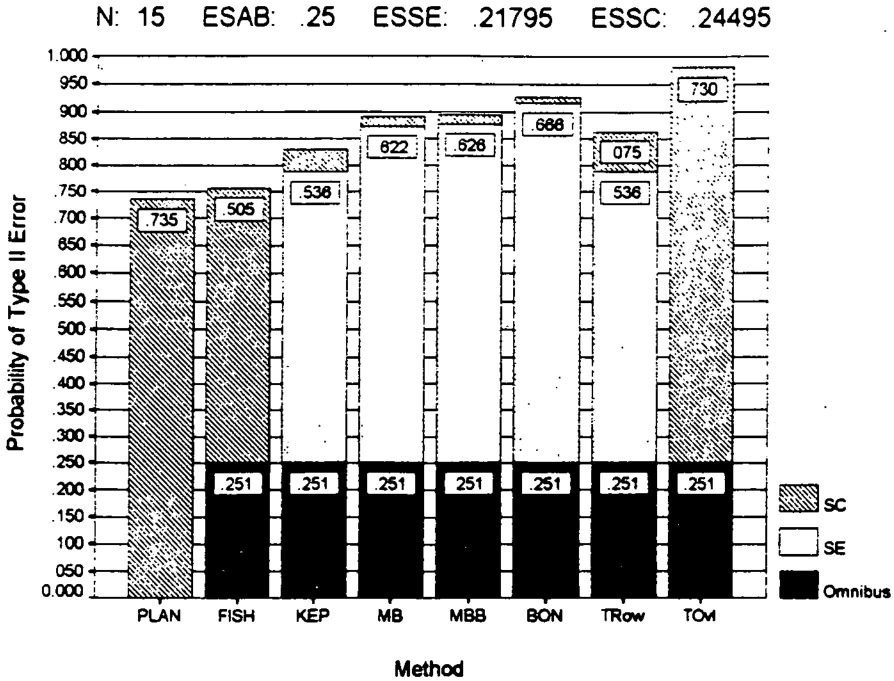
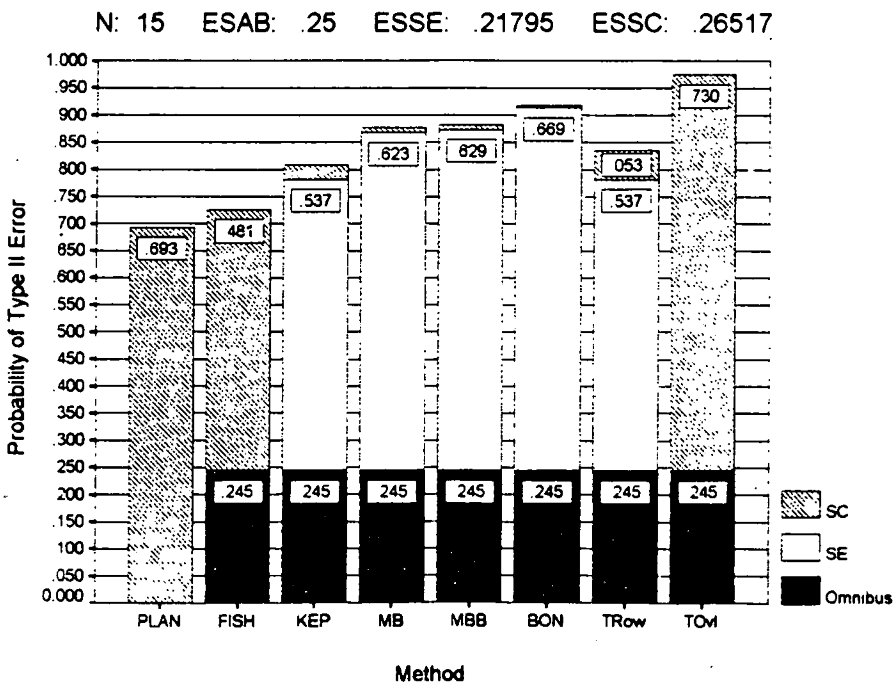
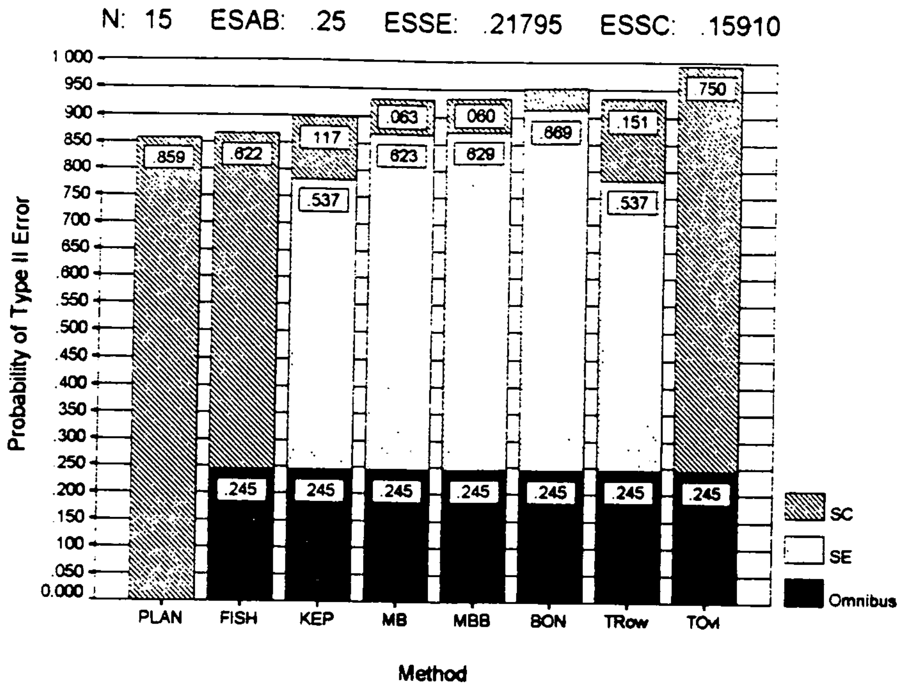
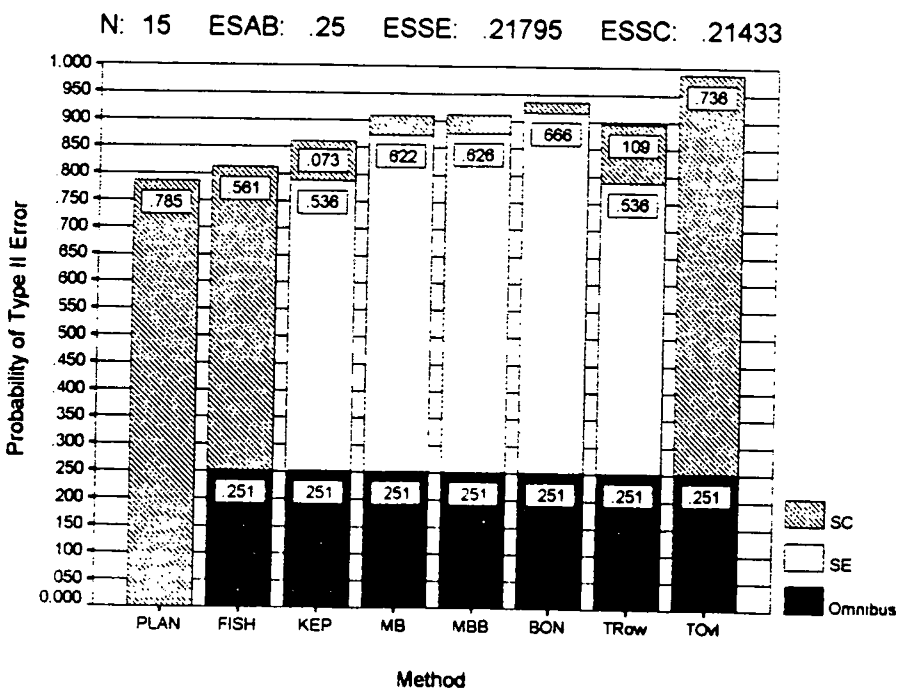
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus

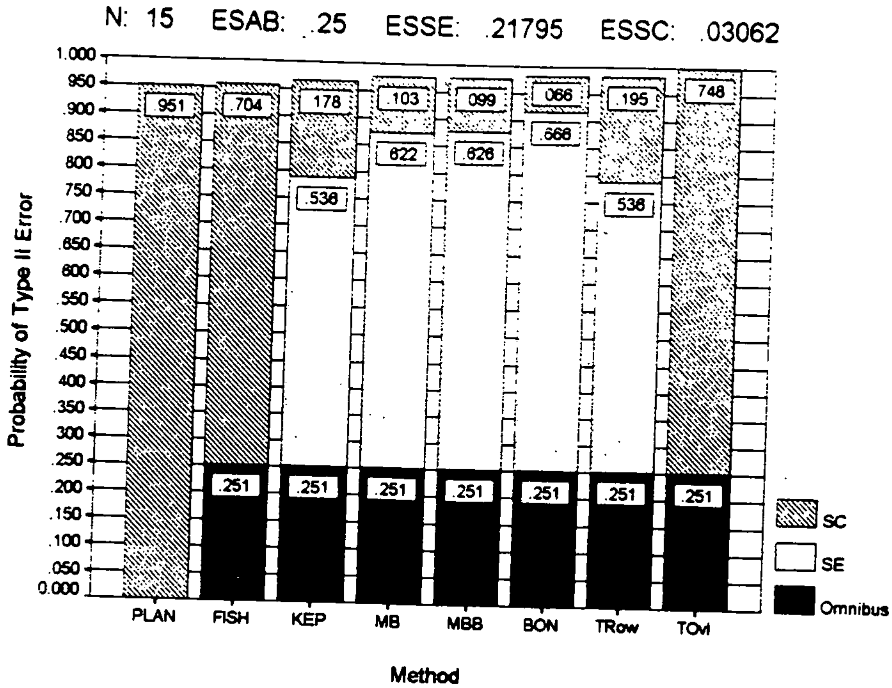

N: 15 ESAB: .25 ESSE: .25000 ESSC: .26517
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 15 ESAB: .25 ESSE: .21795 ESSC: .24495
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus
.735
.505
.536
.622
.626
.686
.075
.536
.730
.251

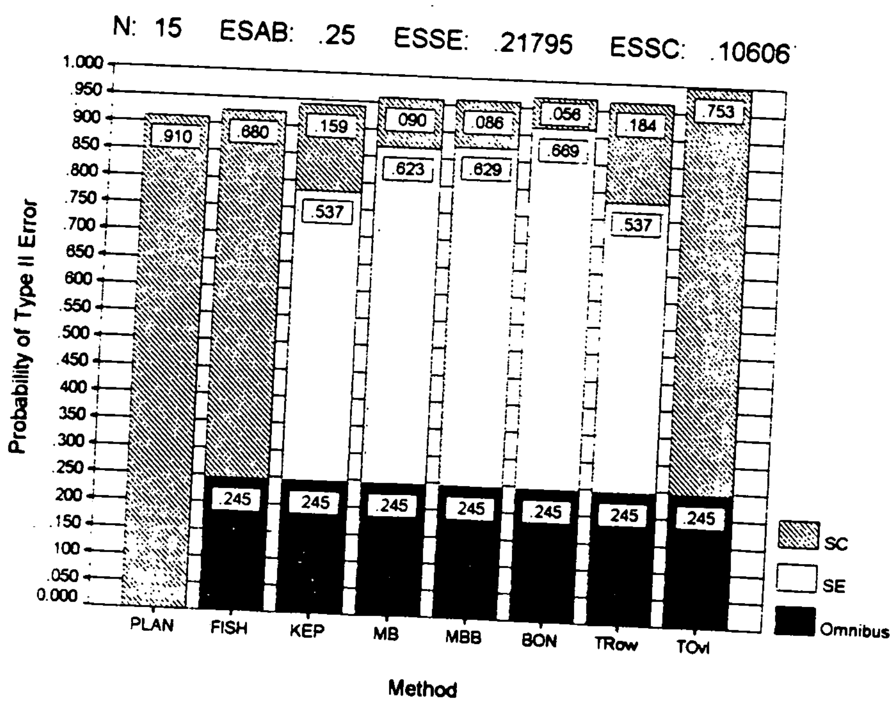

N: 15 ESAB: .25 ESSE: .21795 ESSC: .26517
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus
.693
.481
.537
.623
.629
.669
.053
.537
.730
.245


N: 15 ESAB: .25 ESSE: .21795 ESSC: .15910
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus

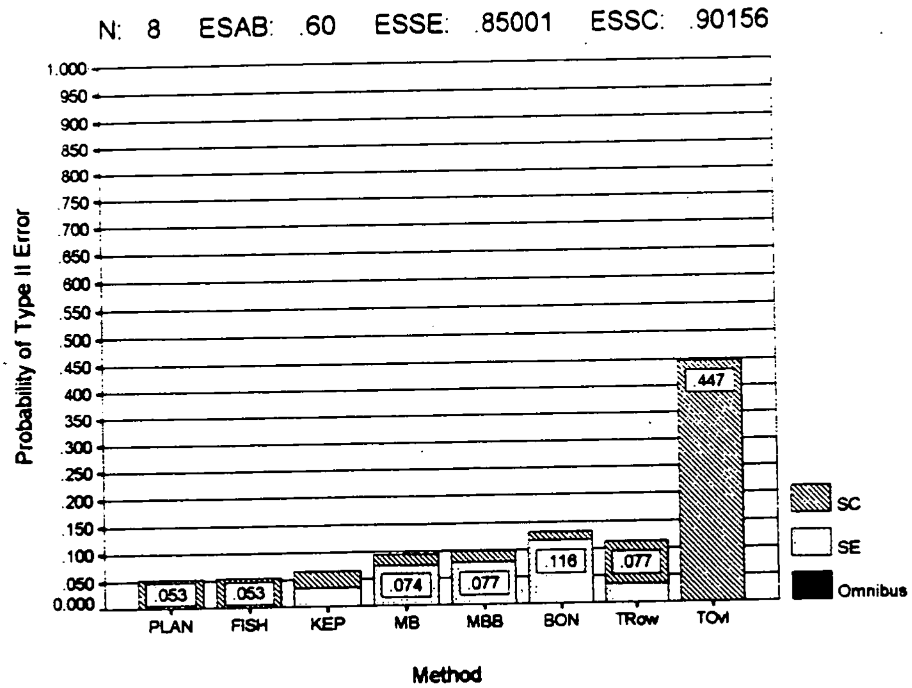

N: 15 ESAB: .25 ESSE: .21795 ESSC: .21433
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus



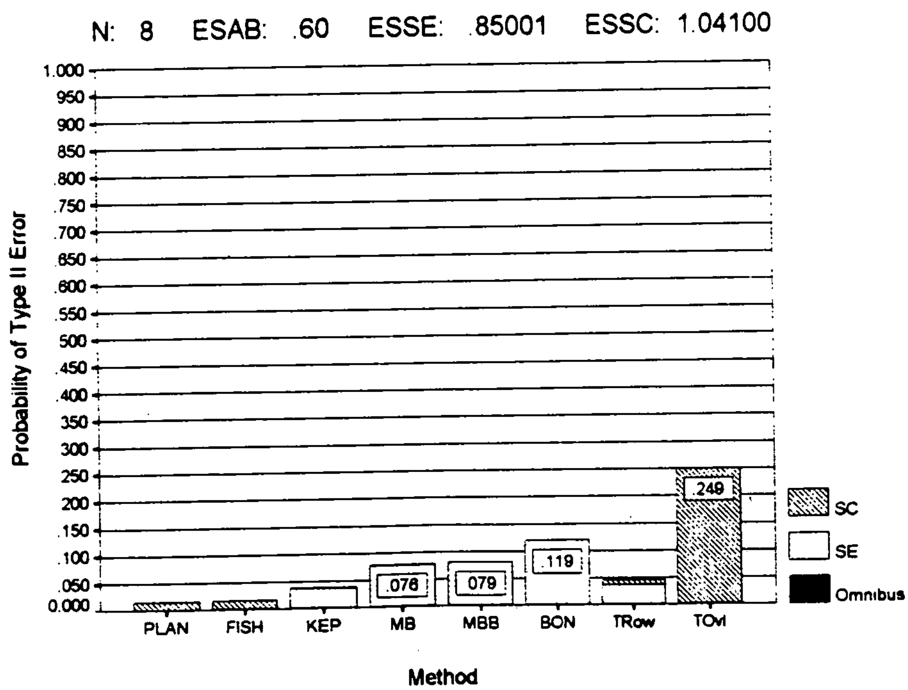
N: 15 ESAB: .25 ESSE: .21795 ESSC: .03062
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.951
.704
.178
.103
.099
.066
.195
.748
.622
.626
.666
.538
.538
.251
.251
.251
.251
.251
.251
.251
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus



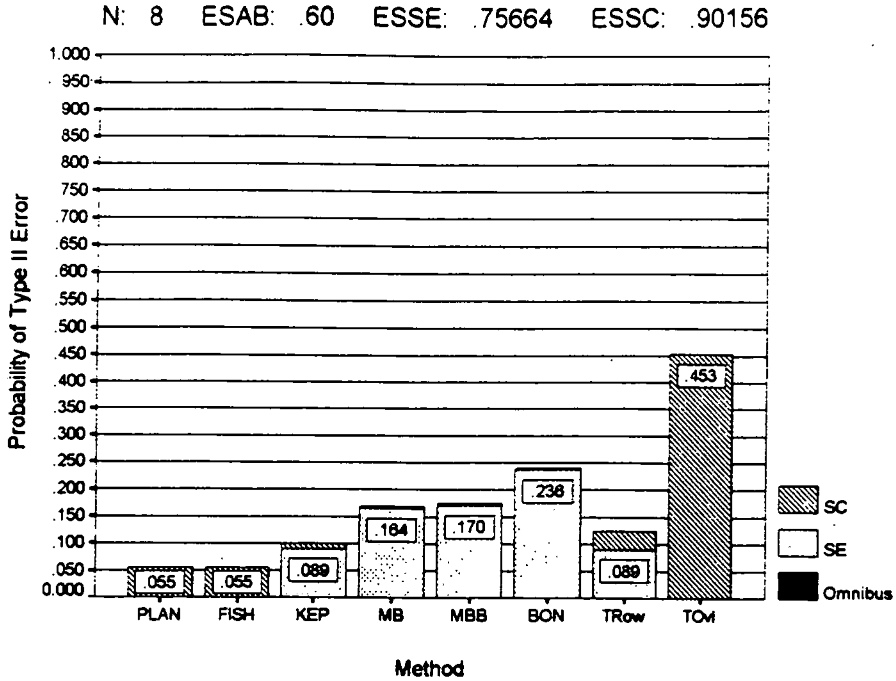
N: 15 ESAB: .25 ESSE: .21795 ESSC: .10606
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.910
.680
.159
.090
.086
.056
.184
.753
.623
.629
.669
.537
.537
.245
.245
.245
.245
.245
.245
.245
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus

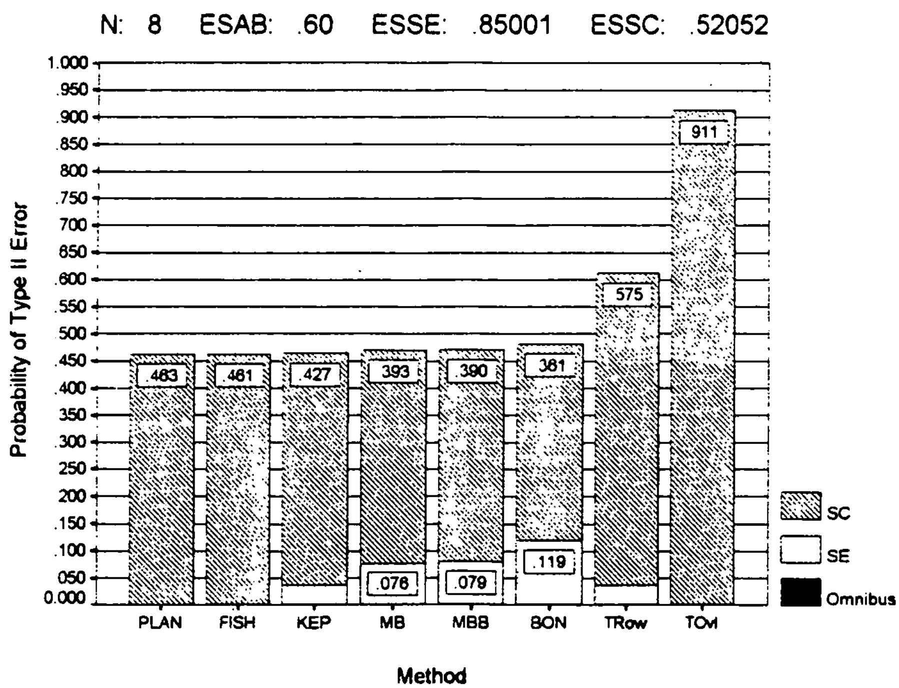


N: 8 ESAB: .60 ESSE: .85001 ESSC: .90156
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.053
.053
.074
.077
.116
.077
.447
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 8 ESAB: .60 ESSE: .85001 ESSC: 1.04100
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.078
.079
.119
.249
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .60 ESSE: .75664 ESSC: .90156
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.055
.055
.089
.164
.170
.238
.089
.453
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus


N: 8 ESAB: .60 ESSE: .85001 ESSC: .52052
Probability of Type II Error
1.000
.950
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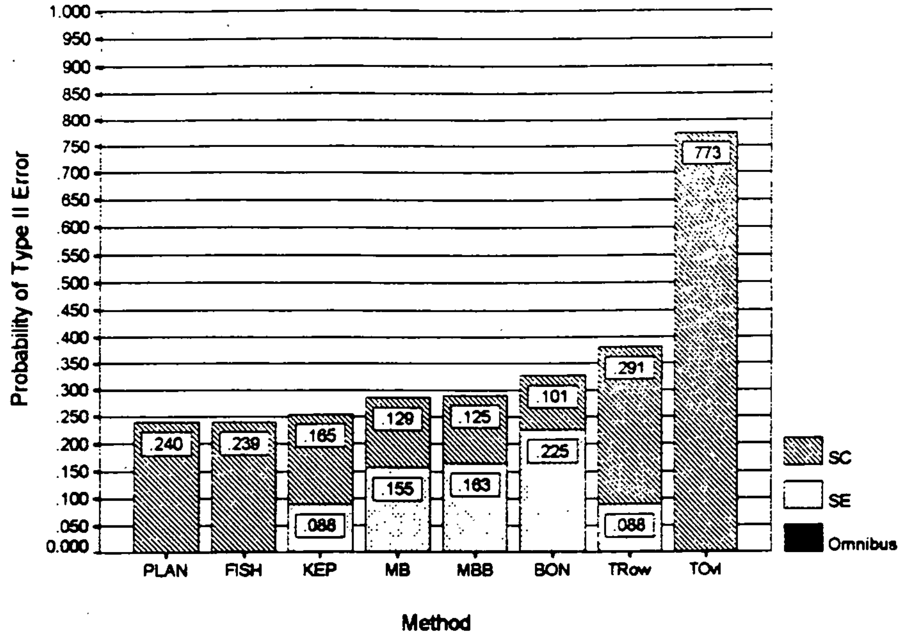
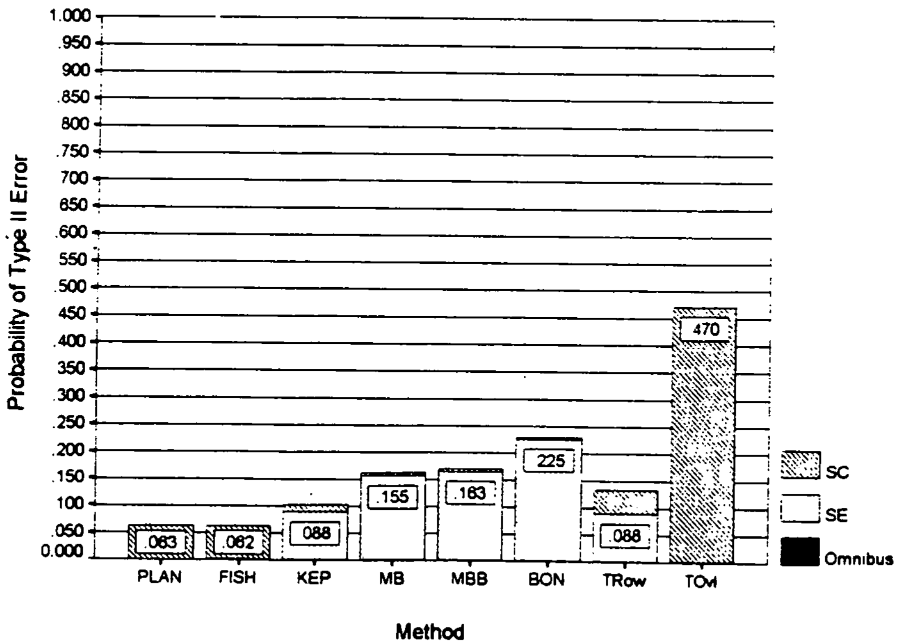
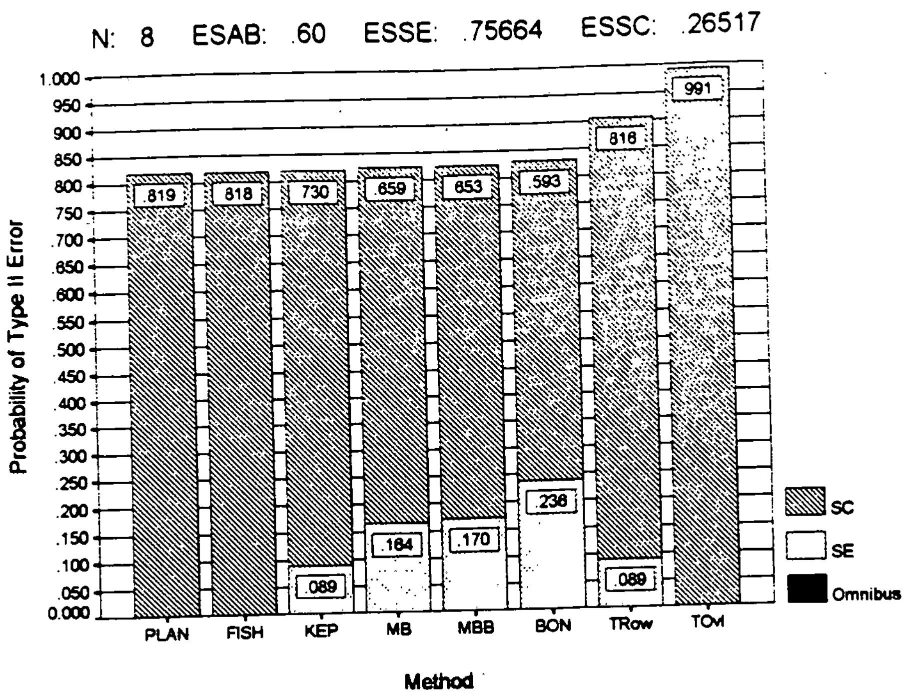
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.463
.461
.427
.393
.390
.361
.575
.911
.076
.079
.119
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus

N: 8 ESAB: .60 ESSE: .75664 ESSC: .67361

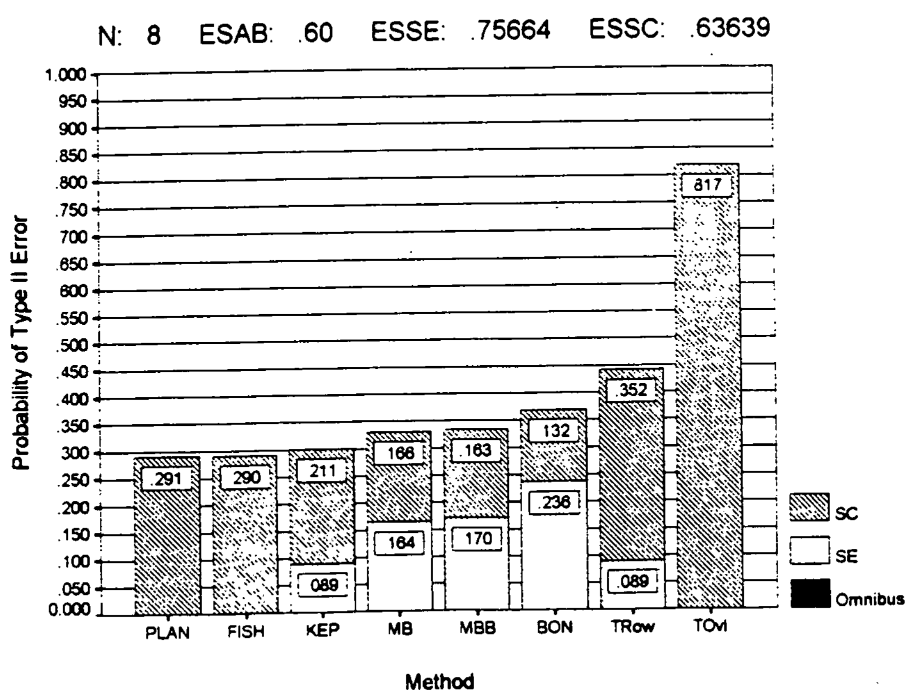


N: 8 ESAB: .60 ESSE: .75664 ESSC: .88795



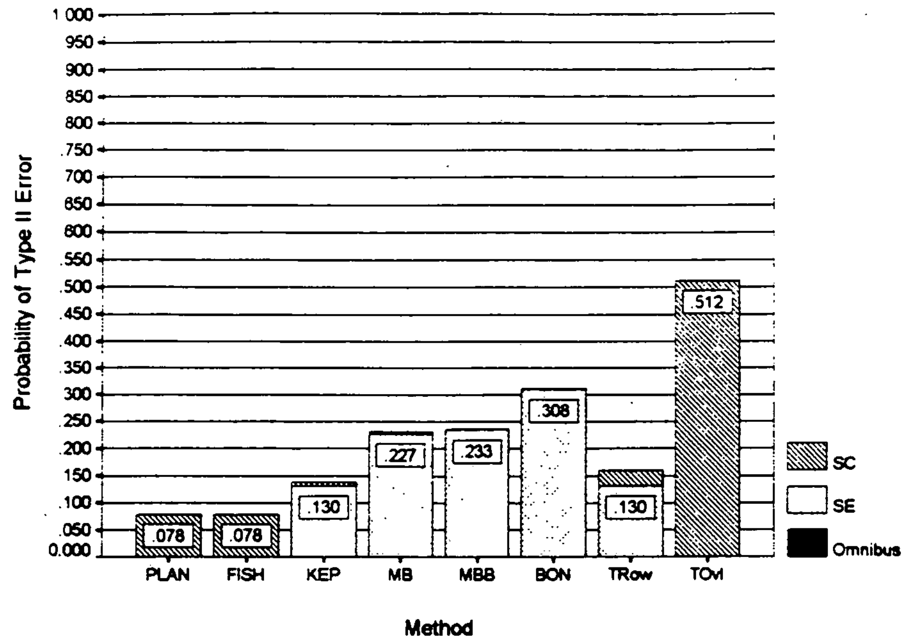


N: 8 ESAB: .60 ESSE: .75664 ESSC: .26517
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.819
.818
.730
.659
.653
.593
.816
.991
.089
.164
.170
.236
.089
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus

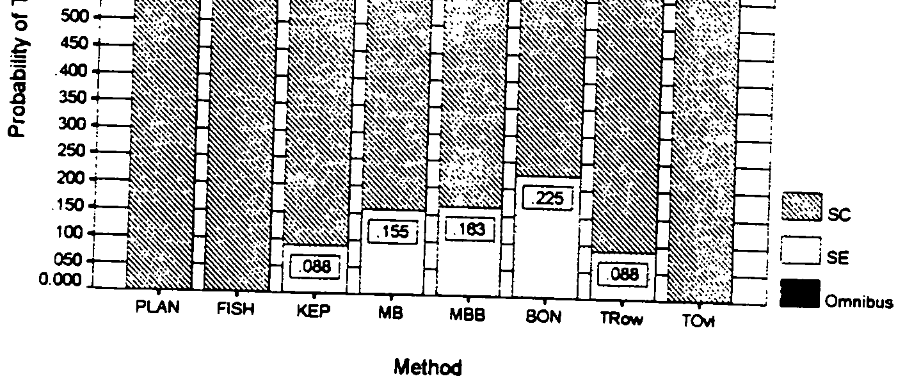


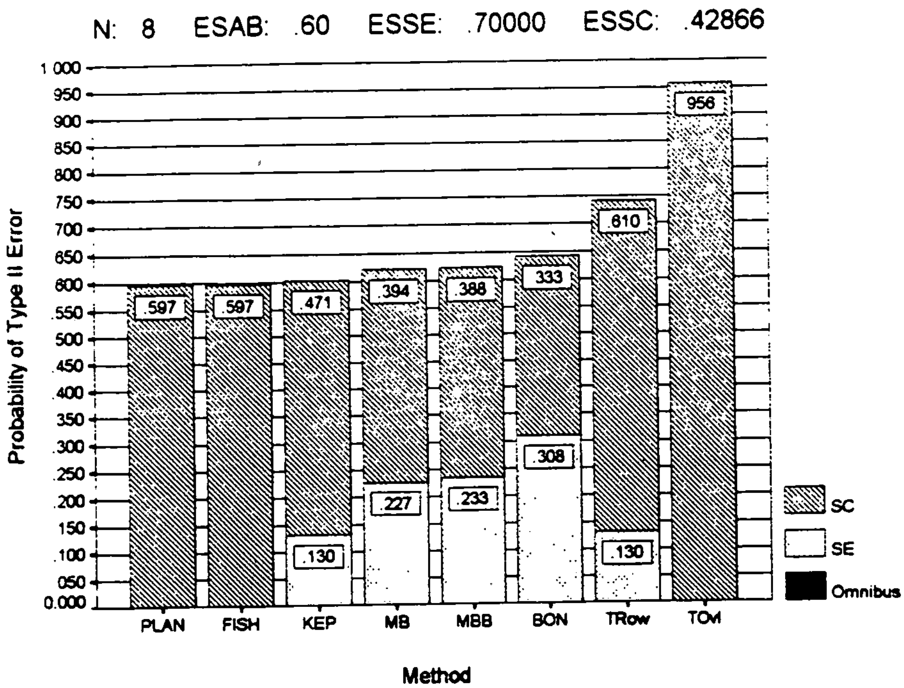
N: 8 ESAB: .60 ESSE: .75664 ESSC: .63639
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.291
.290
.211
.166
.163
.132
.352
.817
.089
.164
.170
.236
.089
PLAN
FISH
KEP
MB
MBB
BON
TRow
TCM
Method
SC
SE
Omnibus

N: 8 ESAB: .60 ESSE: .70000 ESSC: .85732



N: 8 ESAB: .60 ESSE: .75664 ESSC: .21433




N: 8 ESAB: .60 ESSE: .70000 ESSC: .42866
1.000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
050
0.000
Probability of Type II Error
.597
.597
.471
.130
.394
.227
.388
.233
333
.308
.610
.130
956
PLAN
FISH
KEP
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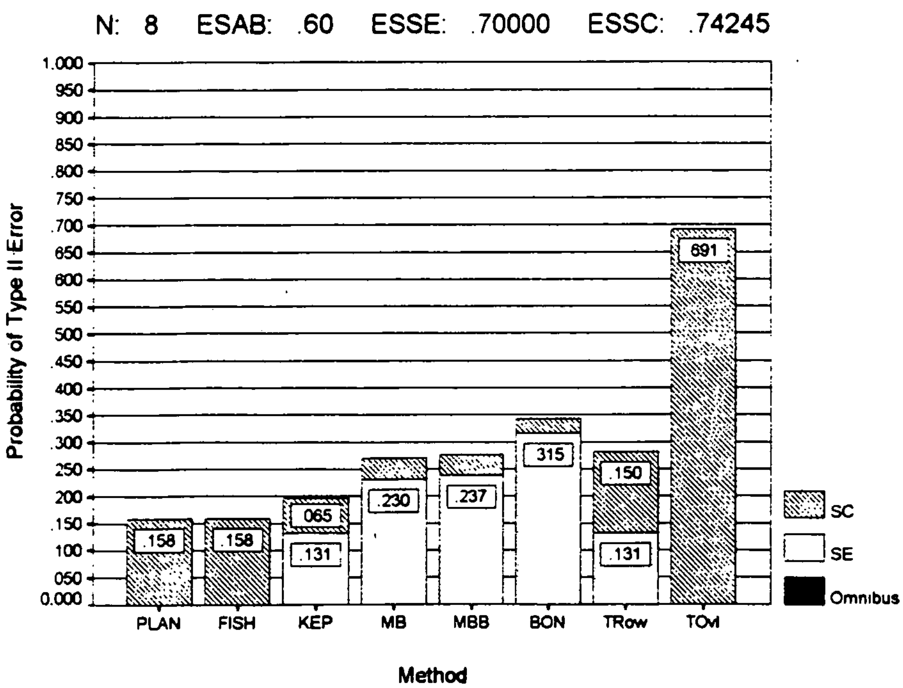
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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900
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800
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700
650
600
550
500
450
400
350
300
250
200
150
100
050
0.000
Probability of Type II Error
.158
.158
065
.131
.230
.237
315
.150
.131
691
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
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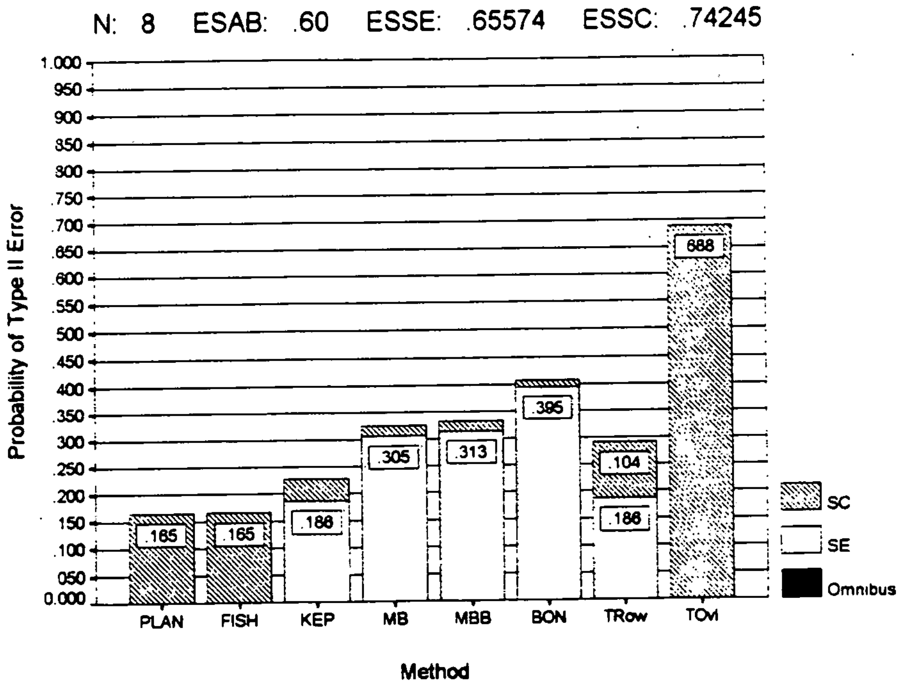
SE
Omnibus


N: 8 ESAB: .60 ESSE: .65574 ESSC: .74245
Probability of Type II Error
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.165
.186
.305
.313
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SC
SE
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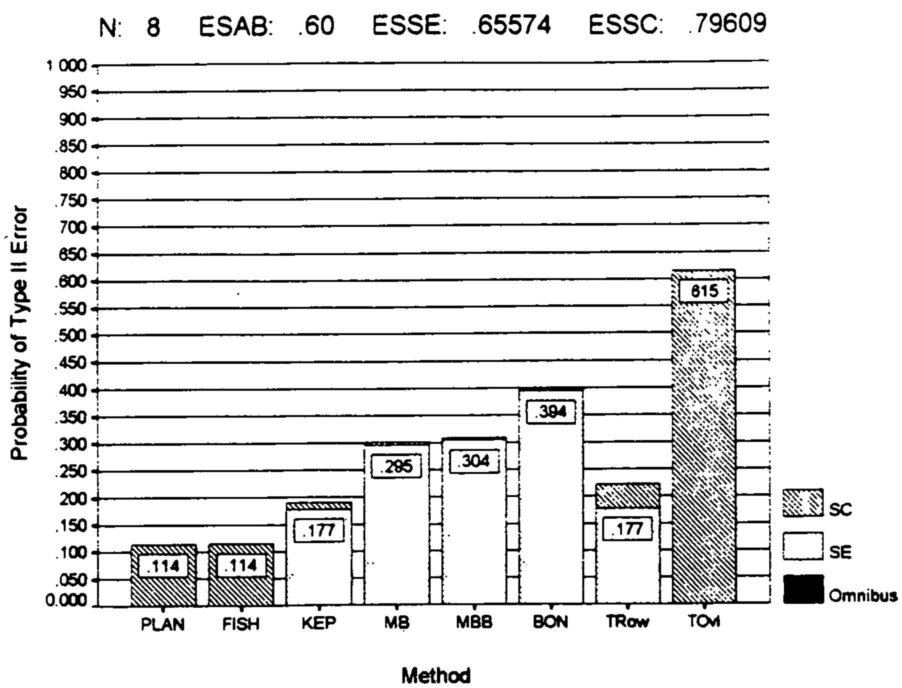
KEP
MB
MBB
BON
TRow
TOM
Method


N: 8 ESAB: .60 ESSE: .65574 ESSC: .79609
Probability of Type II Error
.114
.114
.177
.295
.304
.394
.177
.615
SC
SE
Omnibus
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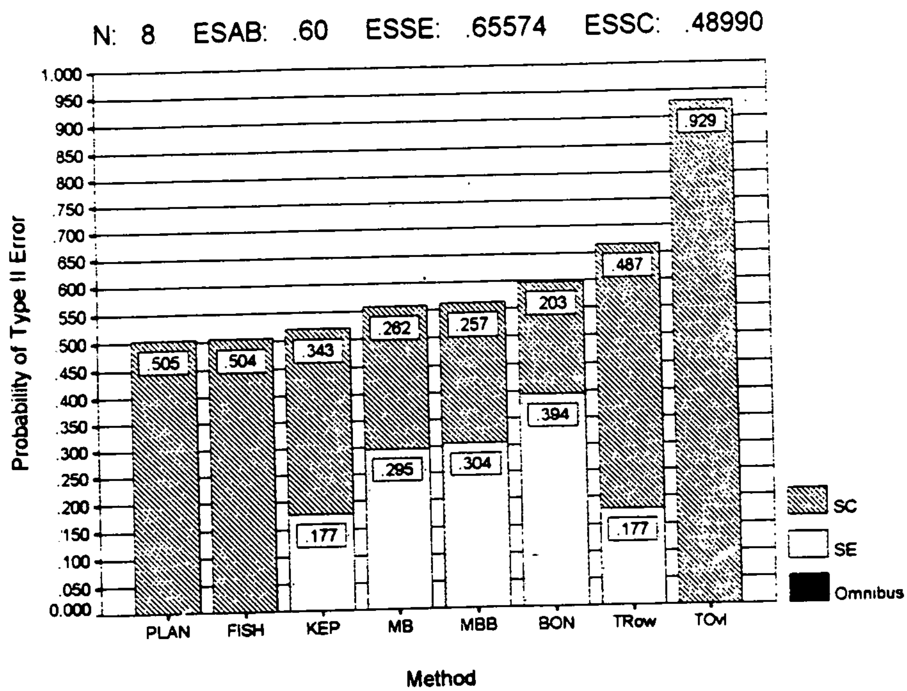
KEP
MB
MBB
BON
TRow
TOM
Method


N: 8 ESAB: .60 ESSE: .65574 ESSC: .48990
Probability of Type II Error
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.800
.750
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.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.505
.504
.343
.177
.262
.295
.257
.304
.203
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.487
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.929
PLAN
FISH
KEP
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MBB
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Method
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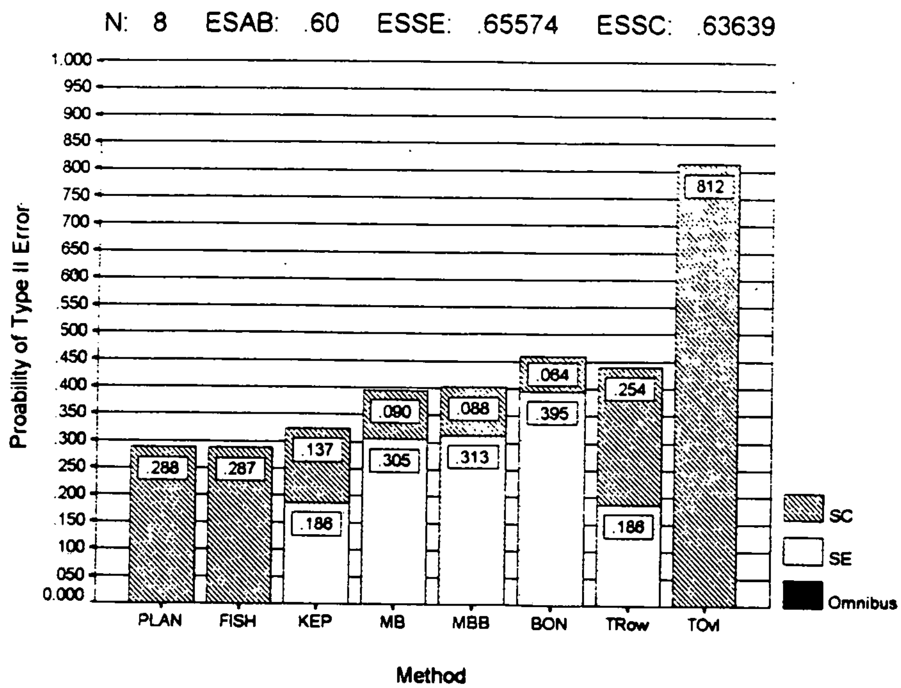
SE
Omnibus


N: 8 ESAB: .60 ESSE: .65574 ESSC: .63639
Proability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.288
.287
.137
.188
.090
.305
.088
.313
.064
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.812
PLAN
FISH
KEP
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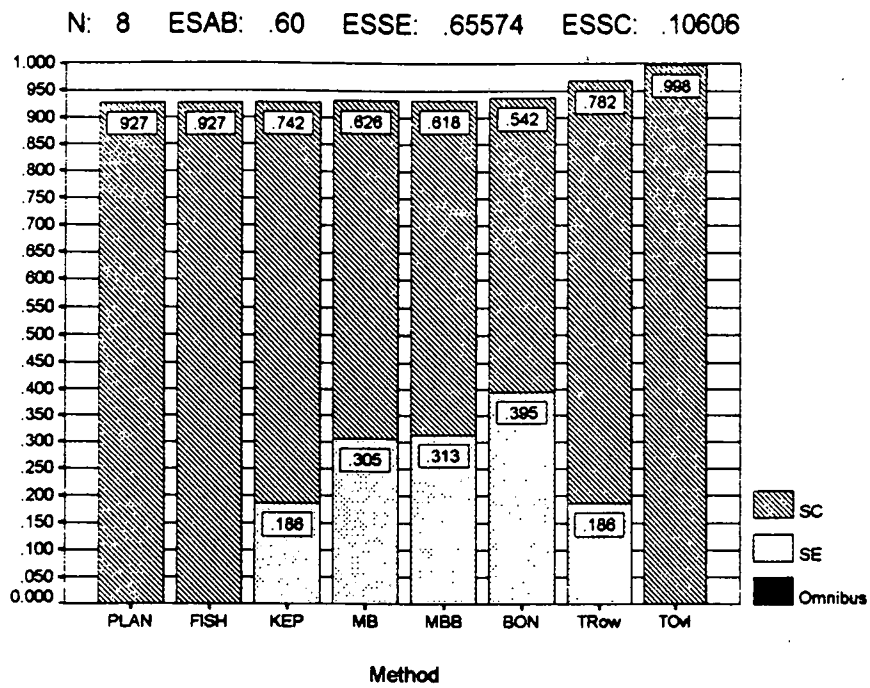
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .60 ESSE: .65574 ESSC: .10606
Probability of Type II Error
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.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.927
.927
.742
.626
.618
.542
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SC
SE
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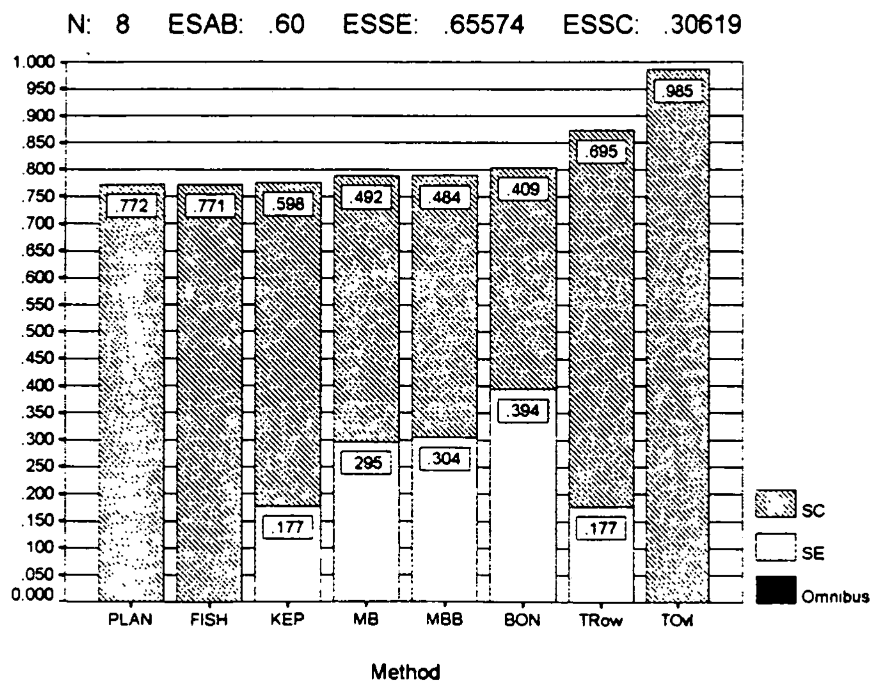
TOM
Method


N: 8 ESAB: .60 ESSE: .65574 ESSC: .30619
Probability of Type II Error
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.350
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.200
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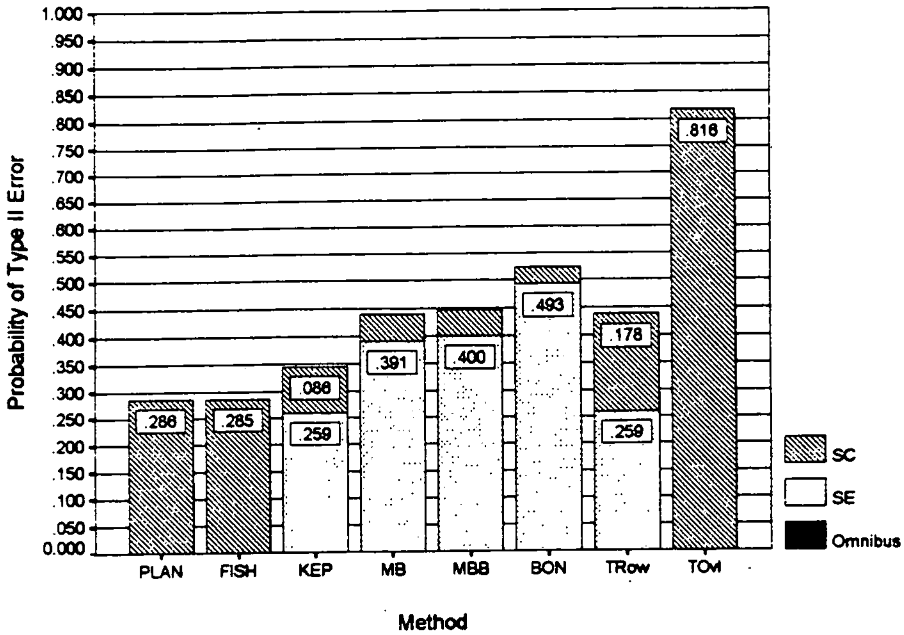
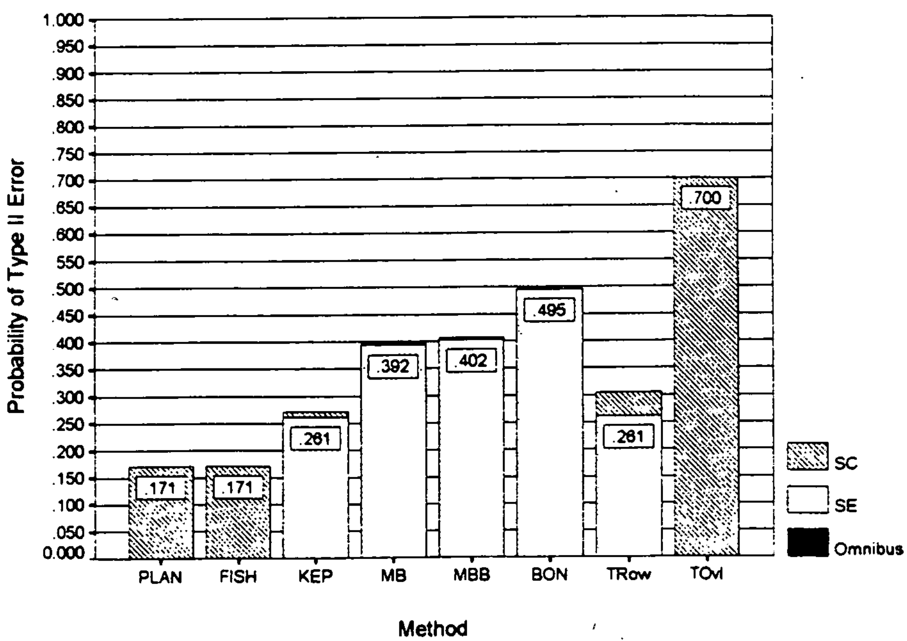
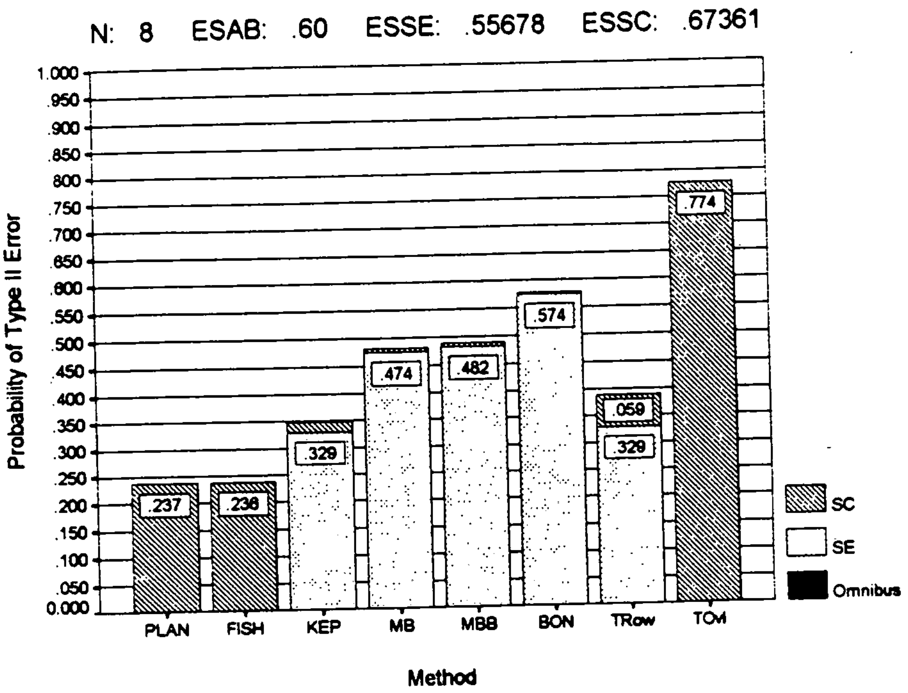
.100
.050
0.000
.772
.771
.598
.492
.484
.409
.695
.985
.394
.295
.304
.177
.177
SC
SE
Omnibus
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method

N: 8 ESAB: .60 ESSE: .60000 ESSC: .63639



N: 8 ESAB: .60 ESSE: .60000 ESSC: .73485





N: 8 ESAB: .60 ESSE: .55678 ESSC: .67361
Probability of Type II Error
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.950
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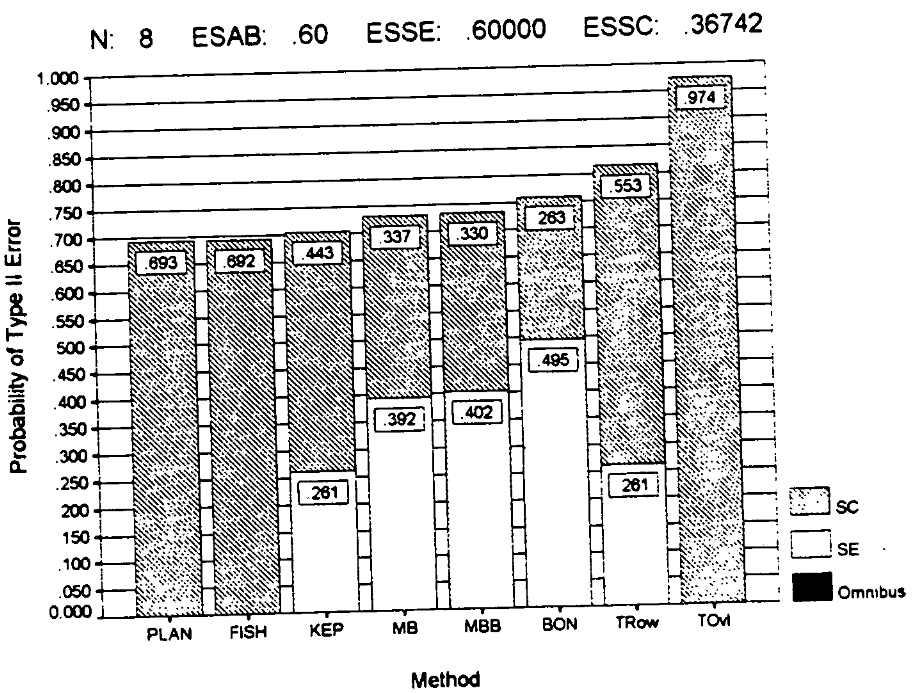
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.237
.236
.329
.474
.482
.574
.059
.329
.774
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus



N: 8 ESAB: .60 ESSE: .60000 ESSC: .36742
Probability of Type II Error
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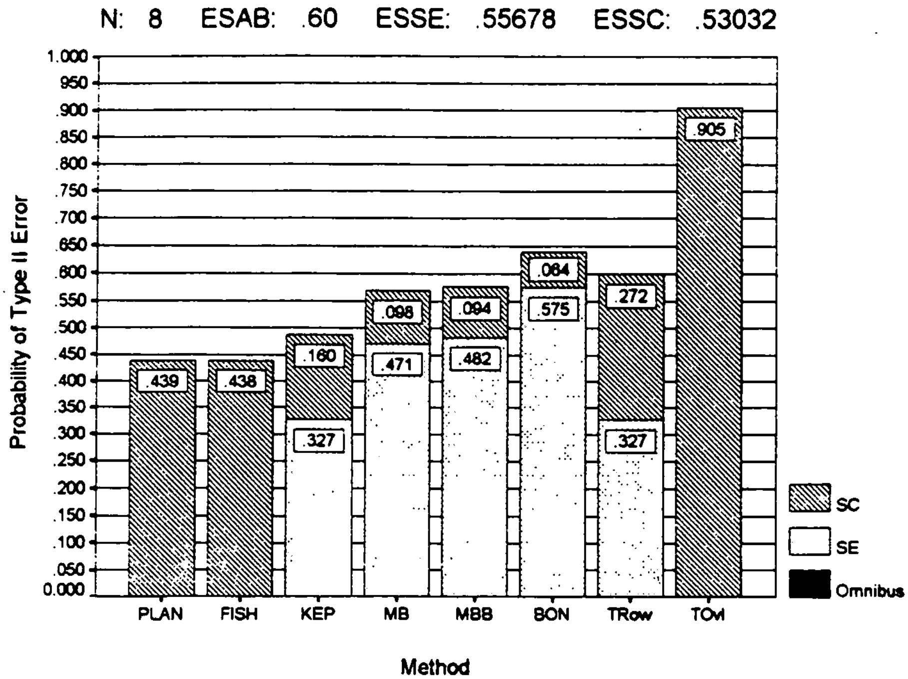
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus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0.000
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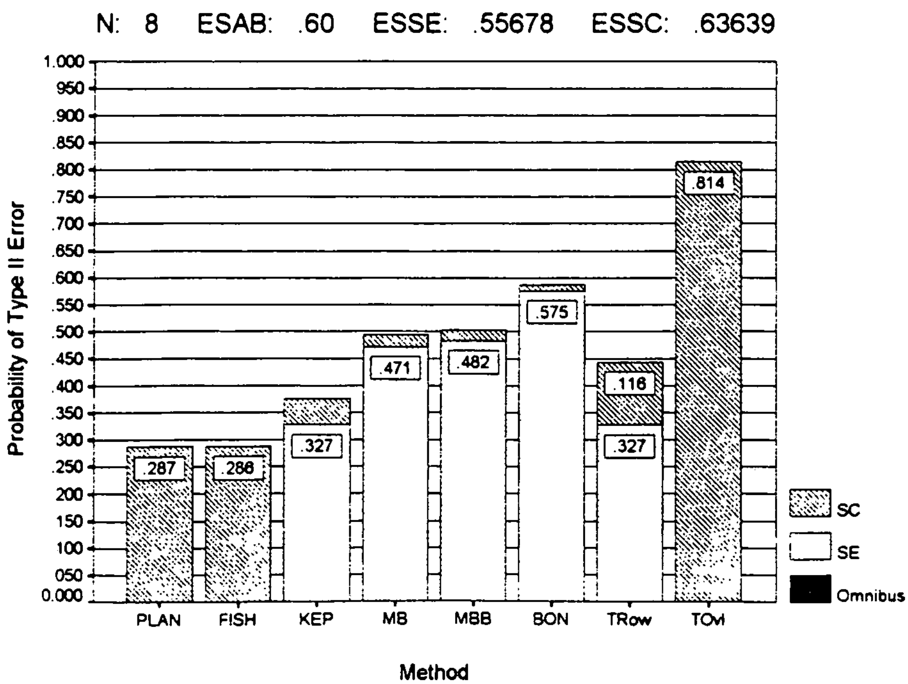
TRow
TOvl
Method
SC
SE
Omnibus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TOvl
Method
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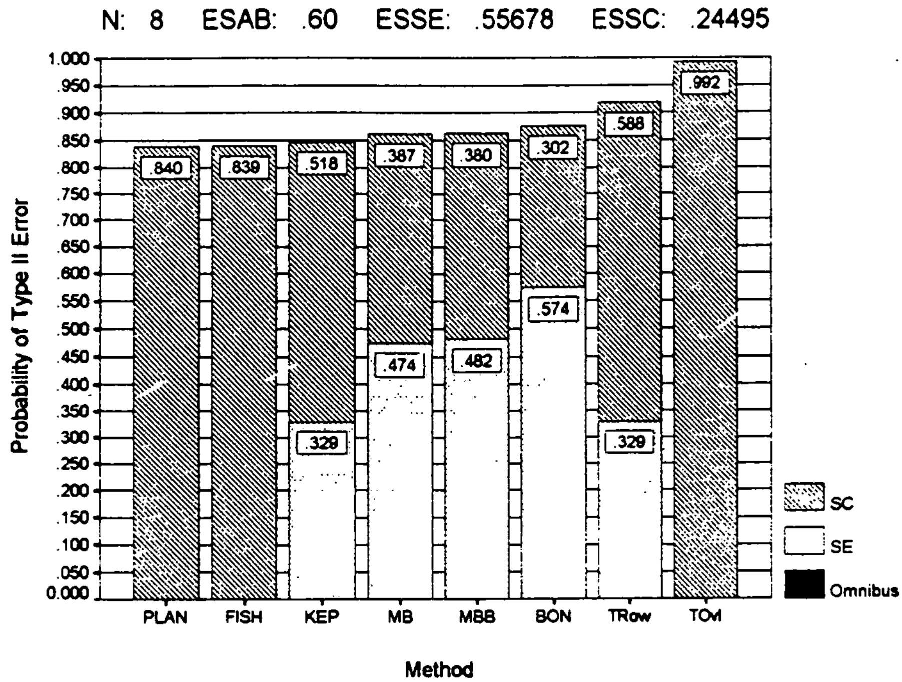
Omnibus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.200
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.100
.050
0.000
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.518
.329
.387
.474
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.482
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Method
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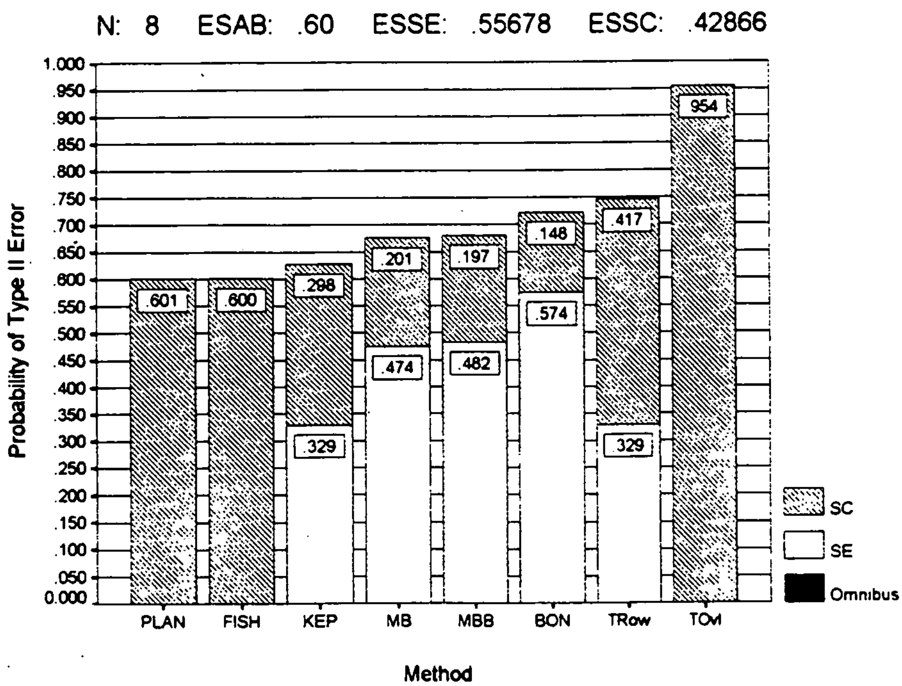
SE
Omnibus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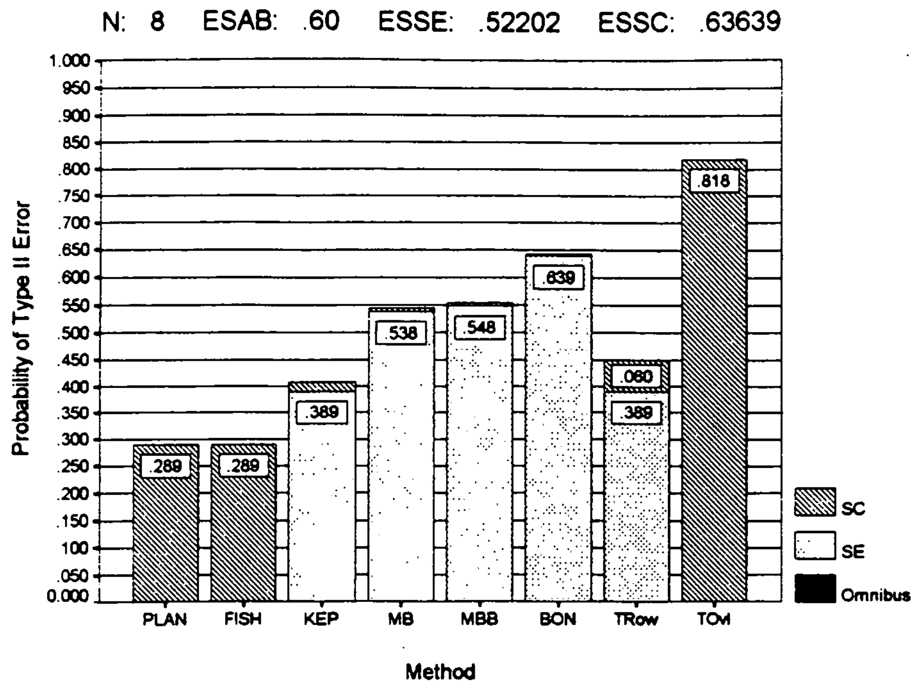
Omnibus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Probability of Type II Error
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.350
.300
.250
.200
.150
.100
.050
0.000
.289
.289
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.538
.548
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Method
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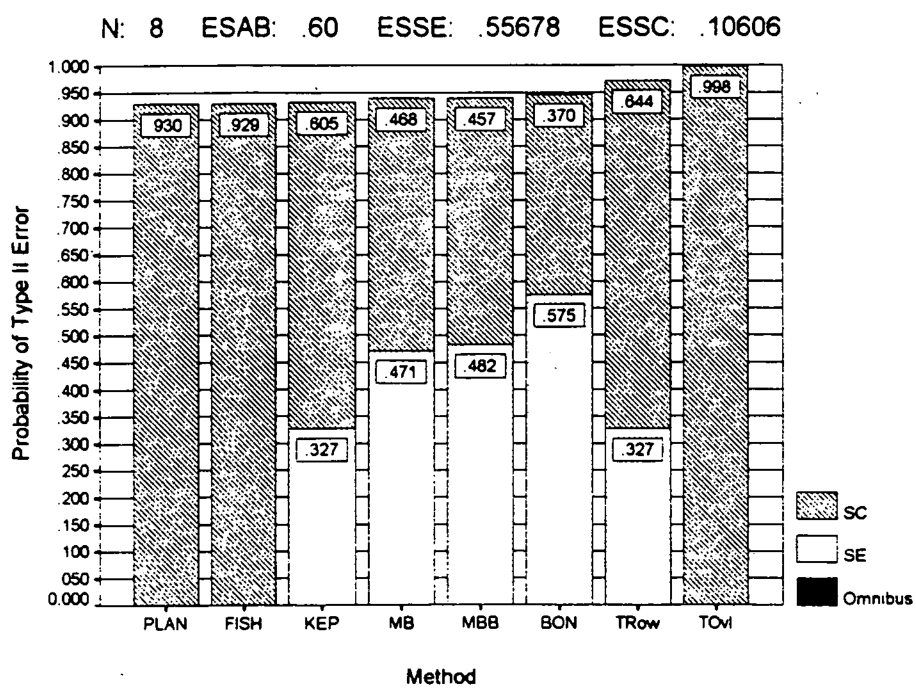
SE
Omnibus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0.000
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.605
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.327
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KEP
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MBB
BON
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TOM
Method
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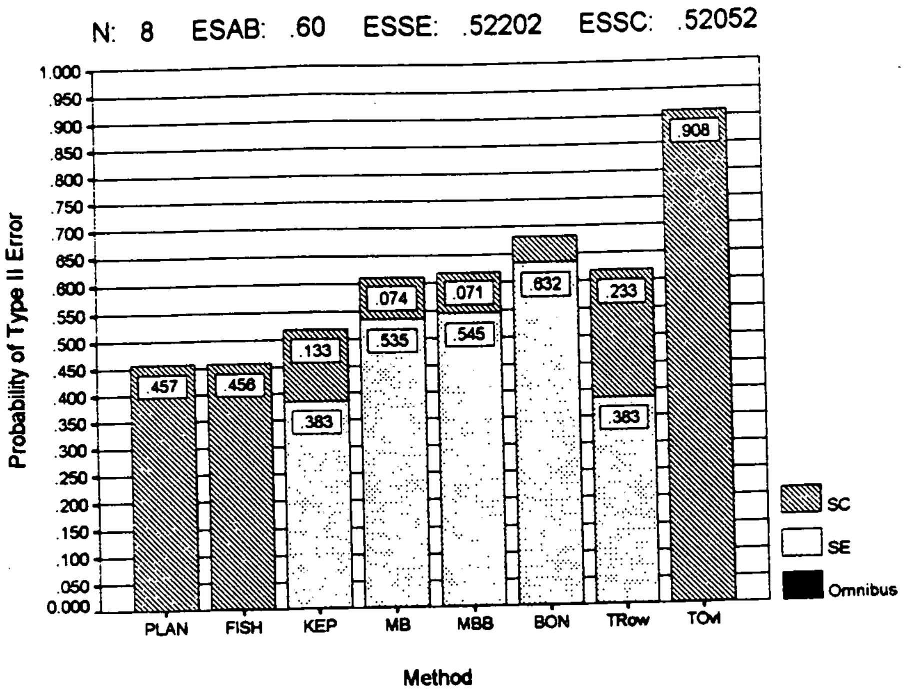
SE
Omnibus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Probability of Type II Error
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.300
.250
.200
.150
.100
.050
0.000
.457
.456
.133
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.535
.071
.545
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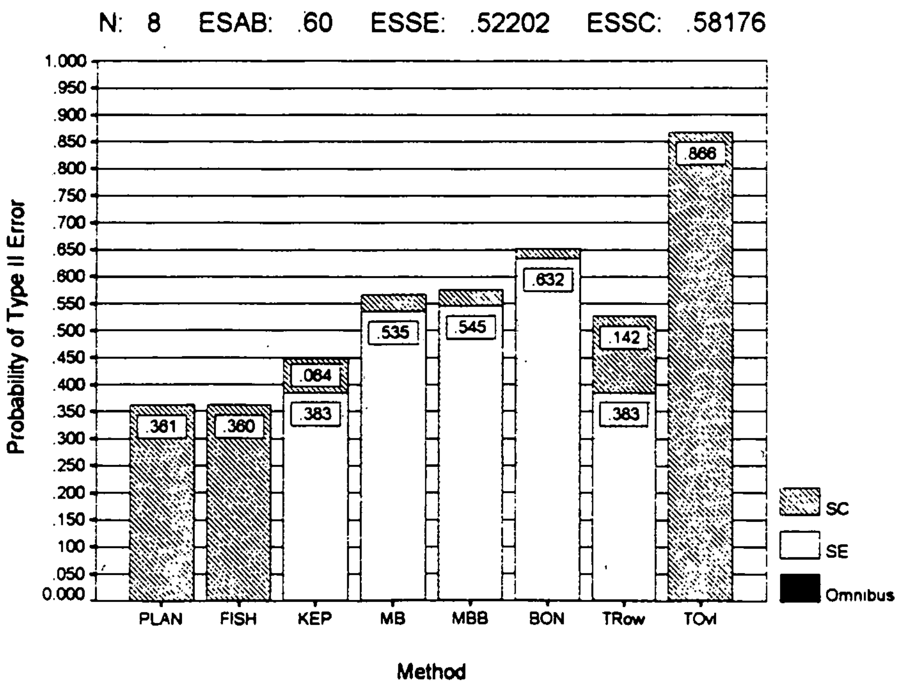
TOM
Method
SC
SE
Omnibus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.450
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.150
100
.050
0.000
.361
.360
.064
.383
.535
.545
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PLAN
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BON
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TOM
Method
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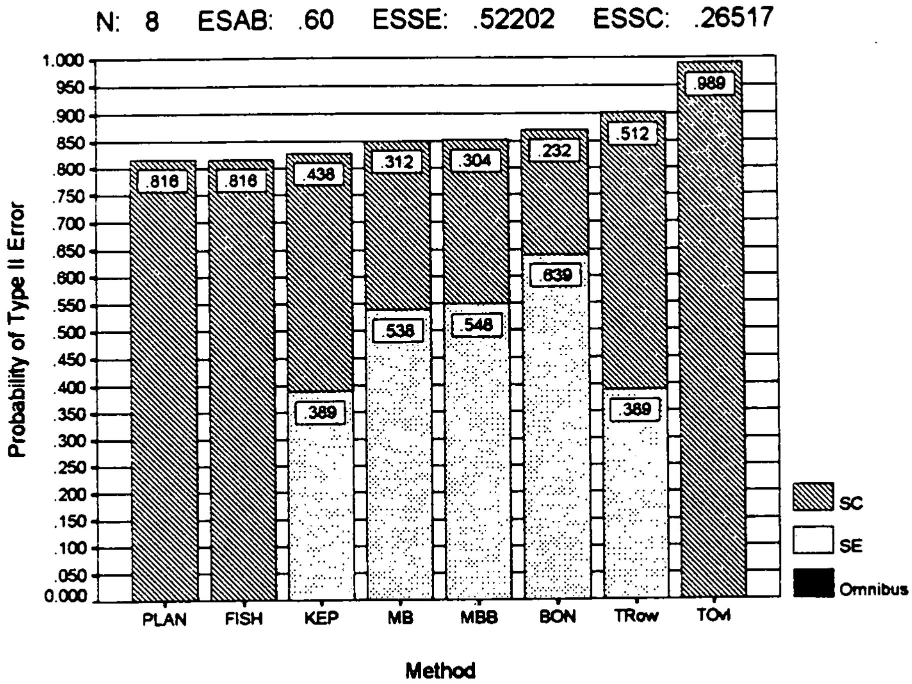
SE
Omnibus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Probability of Type II Error
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.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.816
.816
.438
.312
.304
.232
.512
.989
.389
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PLAN
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Method
SC
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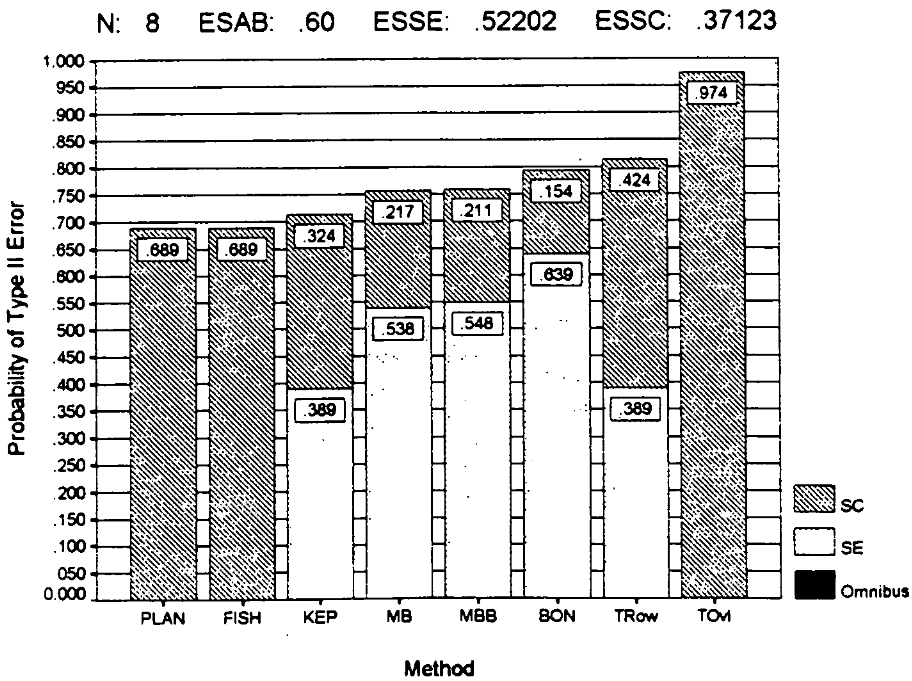
Omnibus


N: 8 ESAB: .60 ESSE: .52202 ESSC: .37123
Probability of Type II Error
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.700
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.600
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.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.689
.689
.324
.217
.211
.154
.424
.974
.389
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PLAN
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KEP
MB
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BON
TRow
TOM
Method
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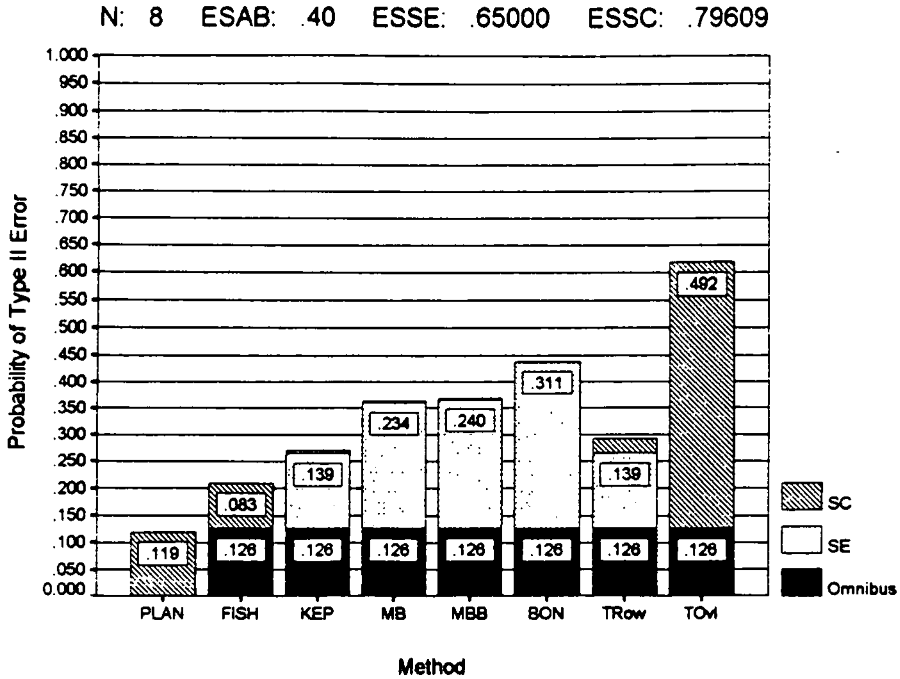
Omnibus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Probability of Type II Error
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.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.119
.083
.126
.139
.234
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PLAN
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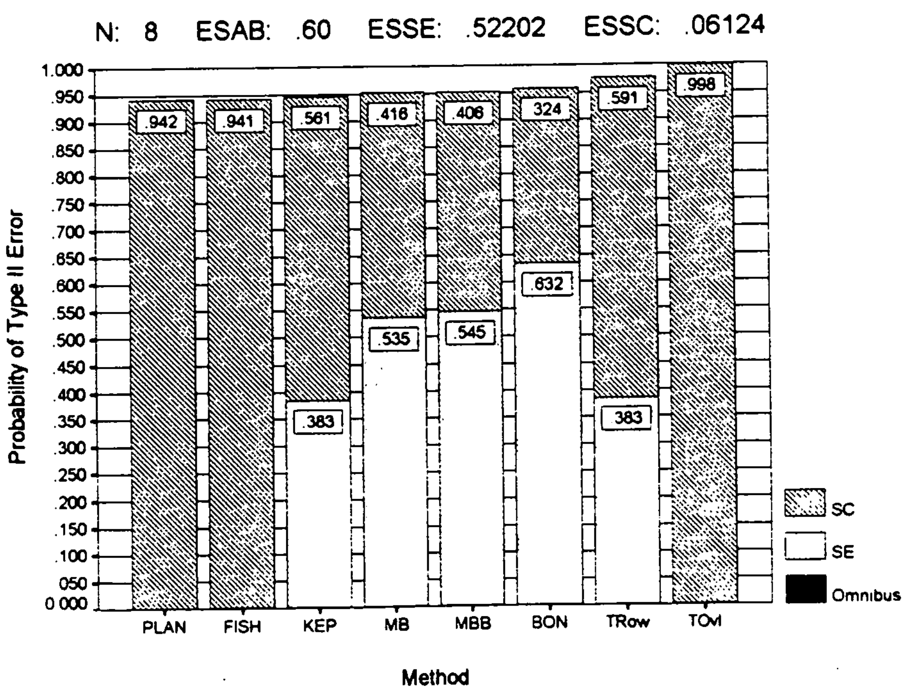
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .60 ESSE: .52202 ESSC: .06124
Probability of Type II Error
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.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.942
.941
.561
.416
.406
.324
.591
.998
.383
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PLAN
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Method
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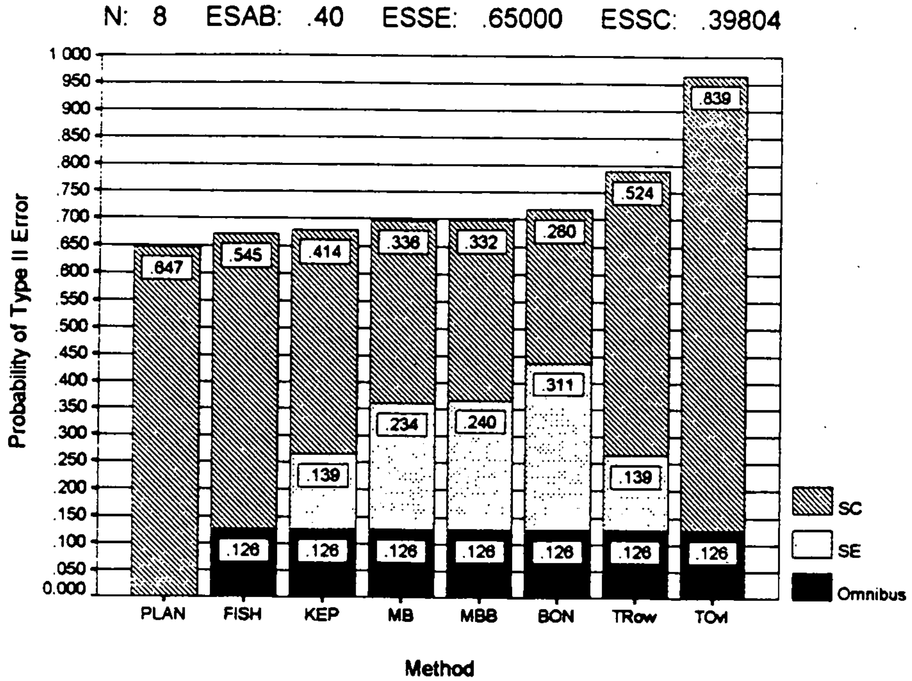
Omnibus



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Probability of Type II Error
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.126
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PLAN
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TOM
Method
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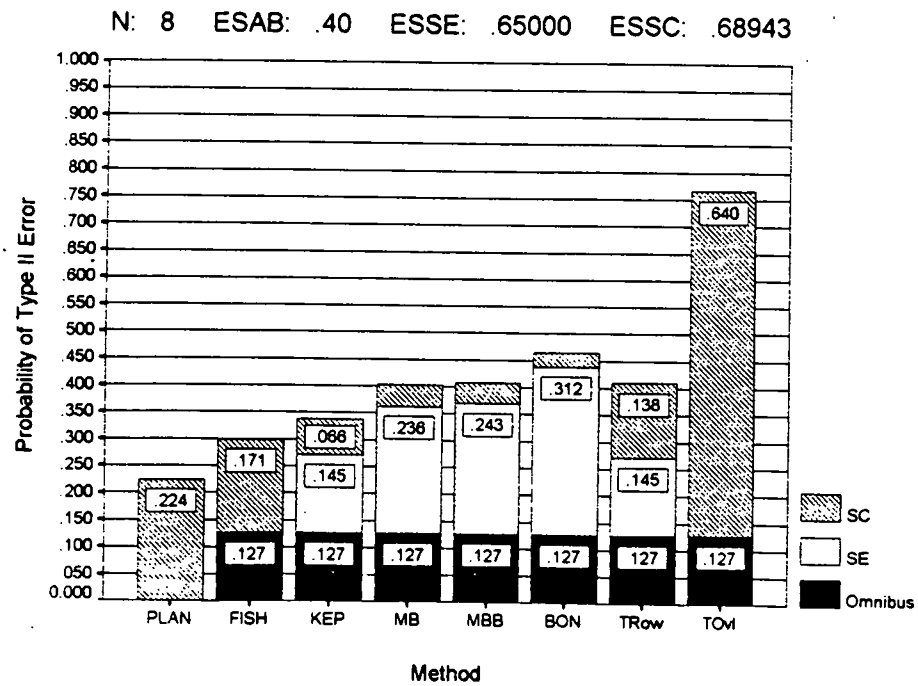
Omnibus



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Probability of Type II Error
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PLAN
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Method
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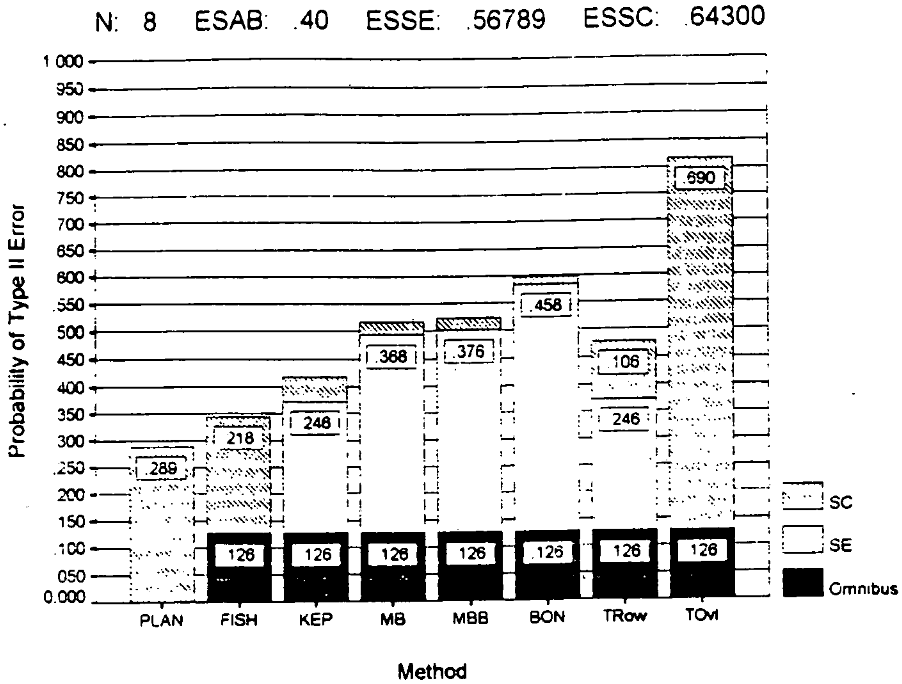
Omnibus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.300
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.200
.150
.100
.050
0.000
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218
246
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.376
.458
106
246
690
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MBB
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TOvl
Method
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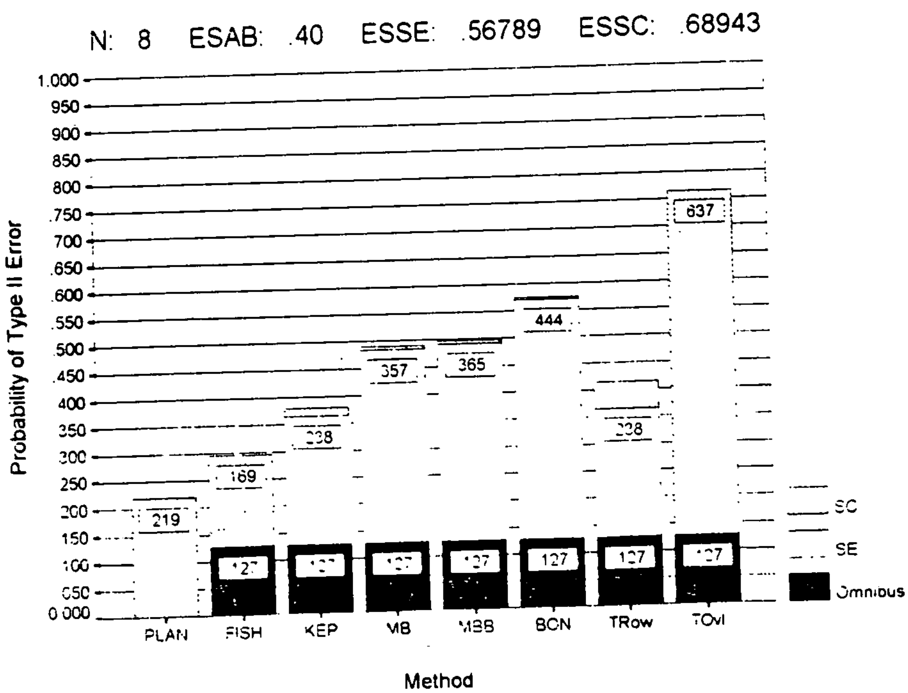
SE
Omnibus


N: 8 ESAB: .40 ESSE: .56789 ESSC: .68943
Probability of Type II Error
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.100
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169
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Method
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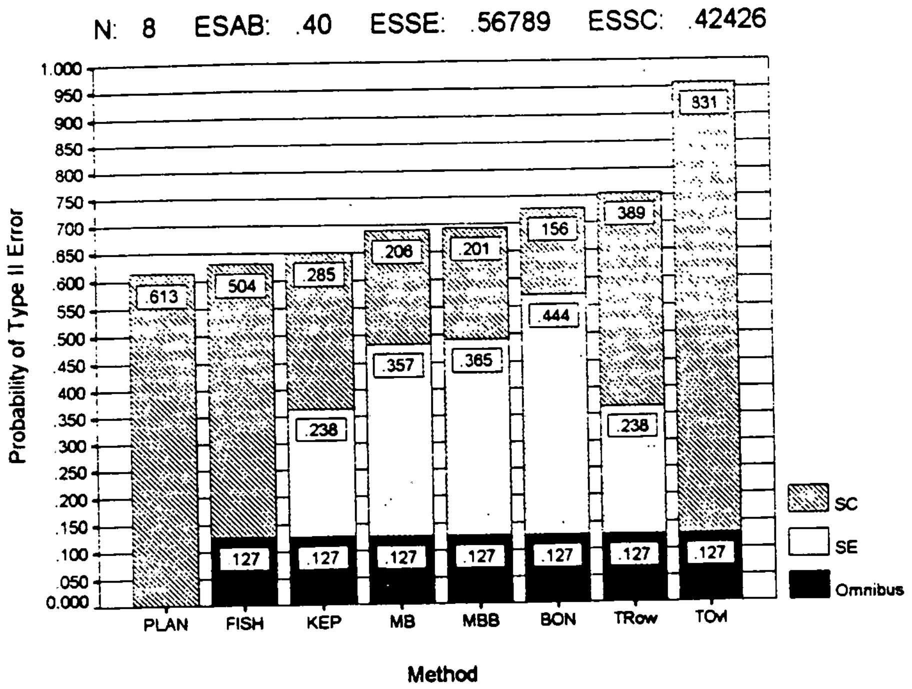
Omnibus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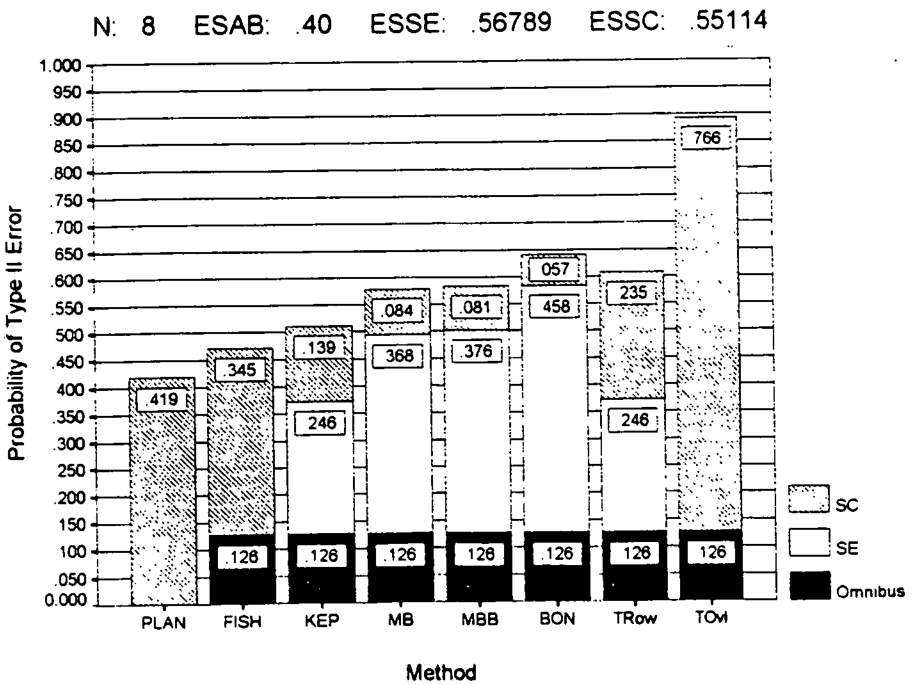
Omnibus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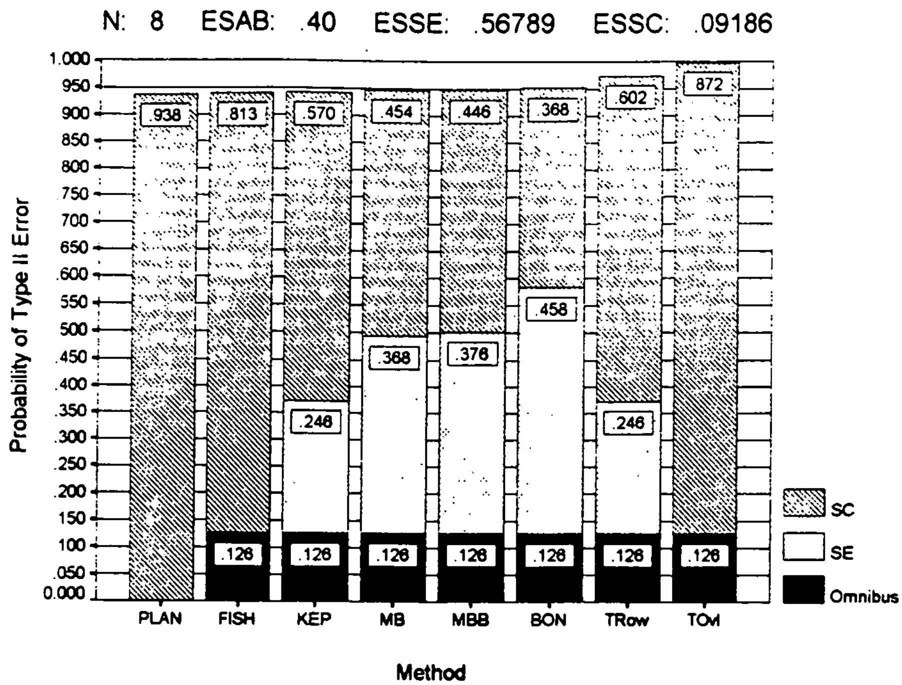
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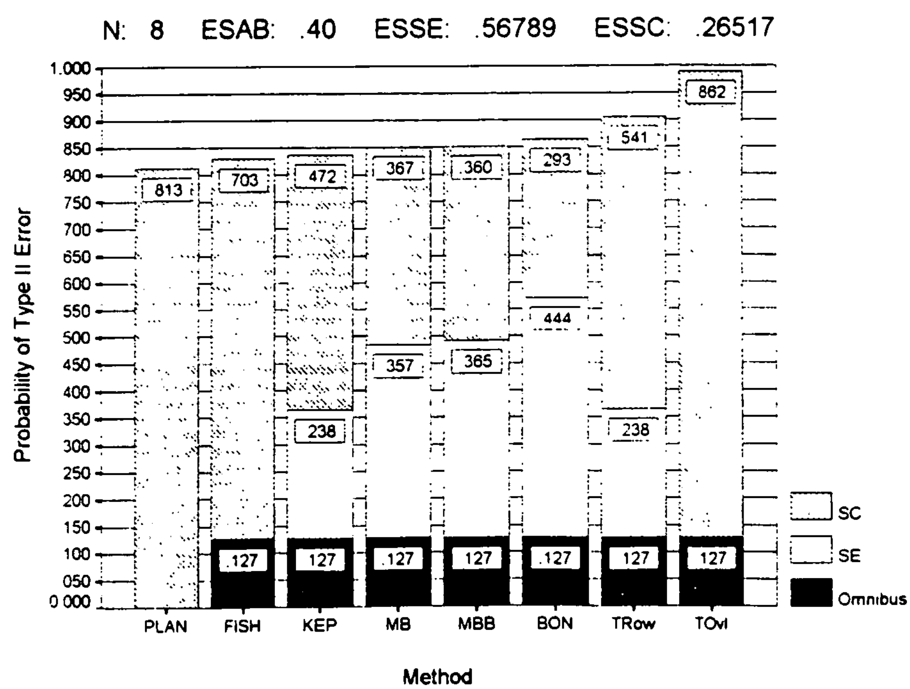
Omnibus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Probability of Type II Error
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050
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472
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Method
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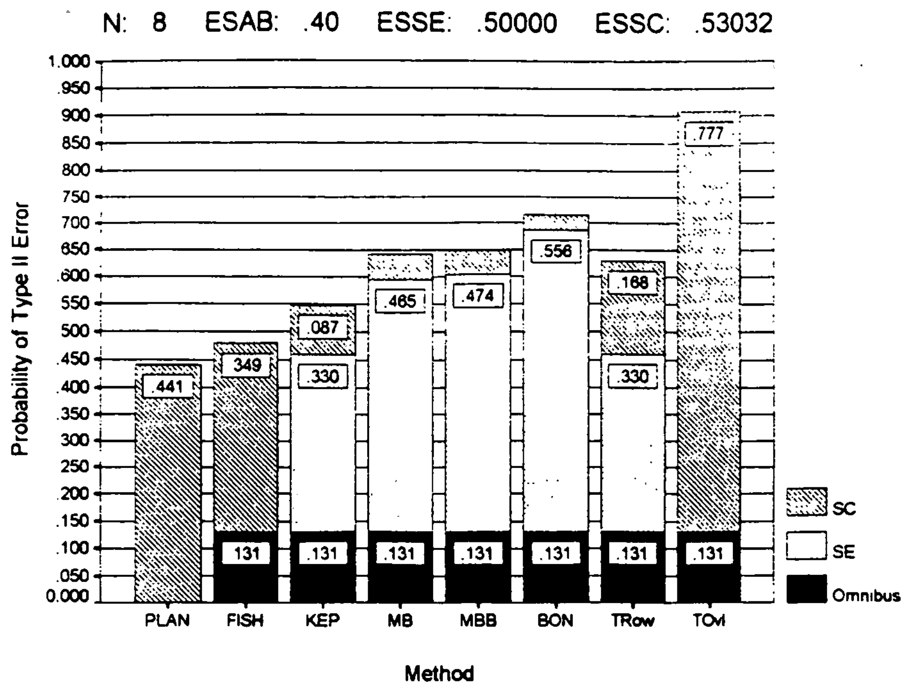
SE
Omnibus


N: 8 ESAB: .40 ESSE: .50000 ESSC: .53032
Probability of Type II Error
Method
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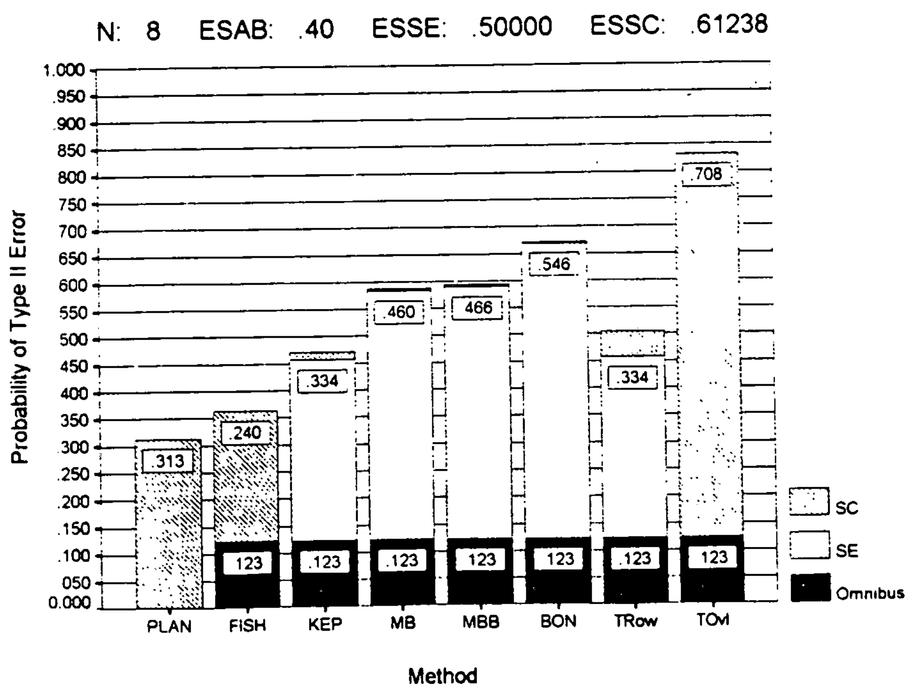
Omnibus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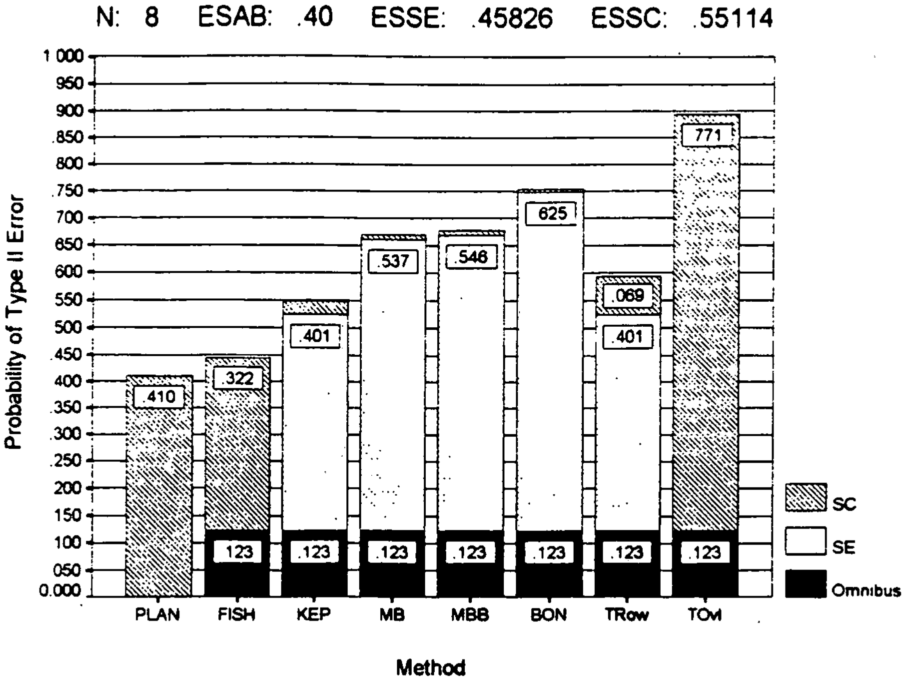
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Method
PLAN
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MBB
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SE
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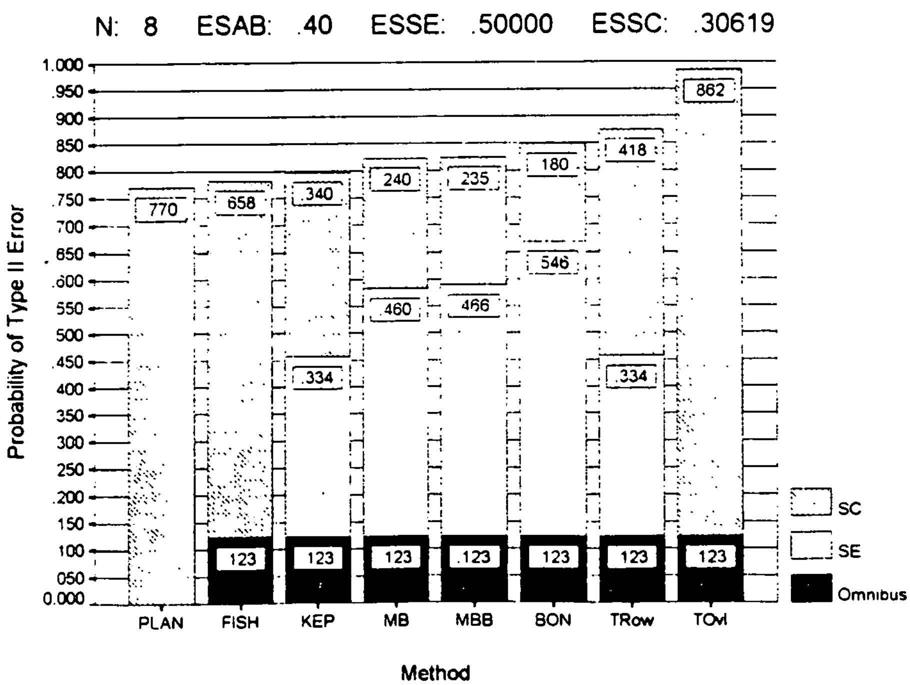
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Probability of Type II Error
Method
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MBB
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TRow
TOM
SC
SE
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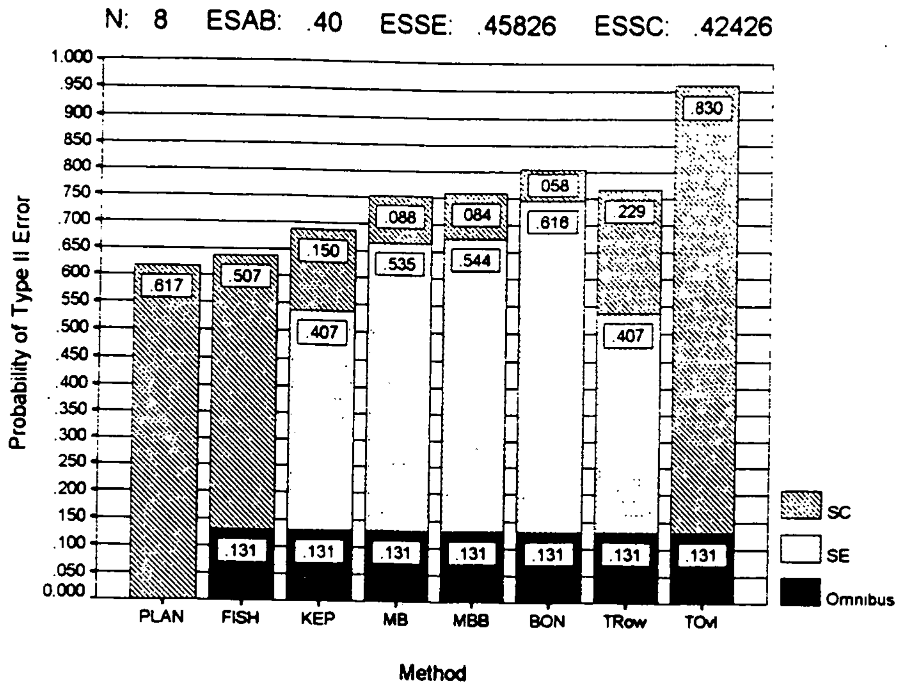

N: 8 ESAB: .40 ESSE: .45826 ESSC: .42426
Probability of Type II Error
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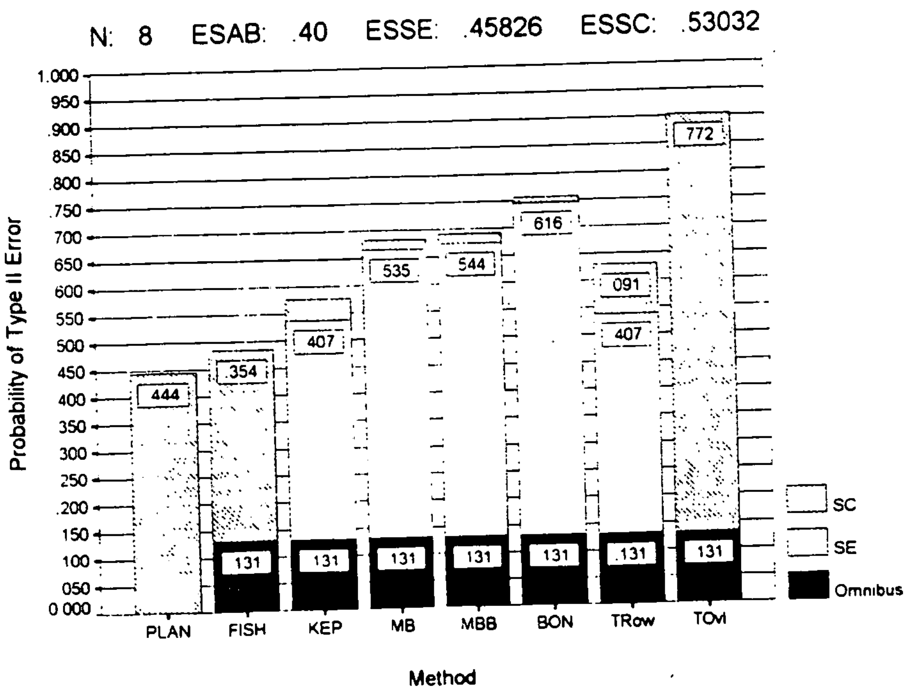
Omnibus



N: 8 ESAB: .40 ESSE: .45826 ESSC: .53032
Probability of Type II Error
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100
050
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444
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407
131
535
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616
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091
407
.131
772
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PLAN
FISH
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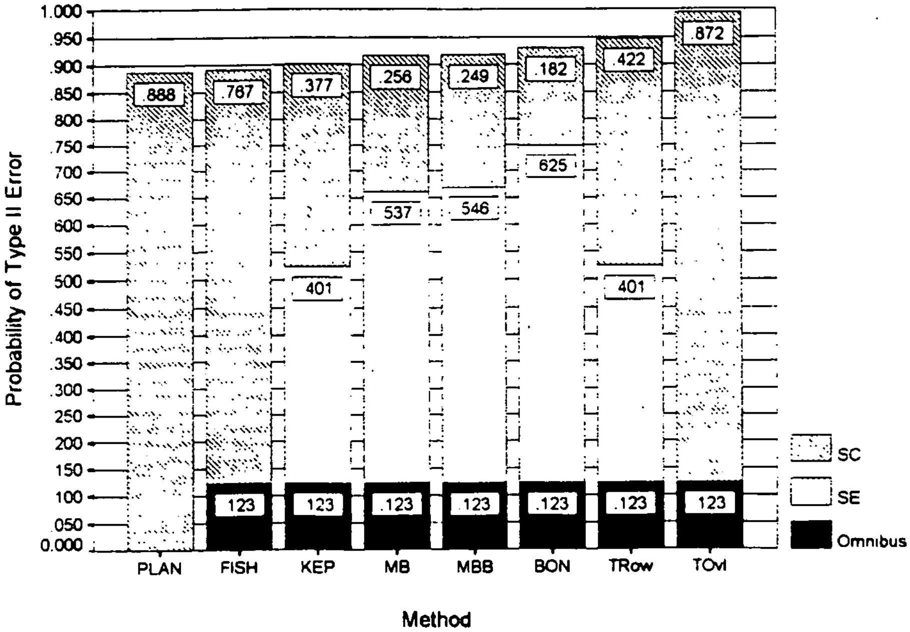
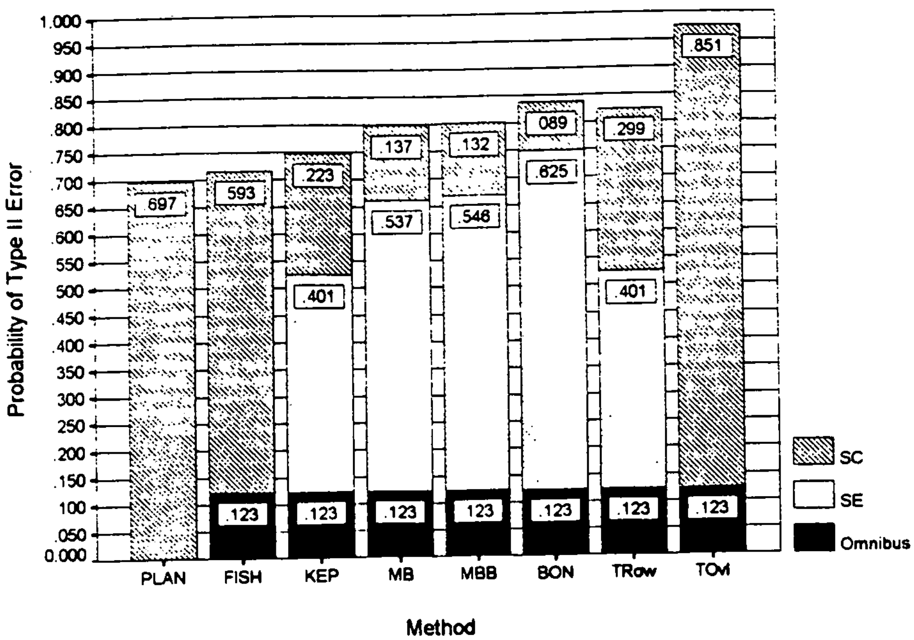
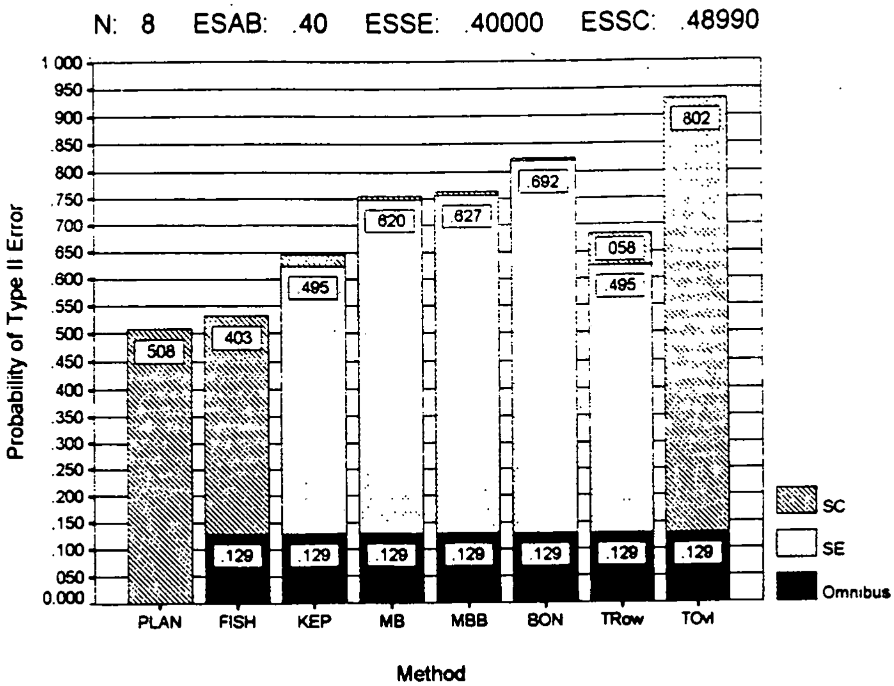
TRow
TOM
Method
SC
SE
Omnibus

N: 8 ESAB: .40 ESSE: .45826 ESSC: .18372



N: 8 ESAB: .40 ESSE: .45826 ESSC: .36742

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Probability of Type II Error
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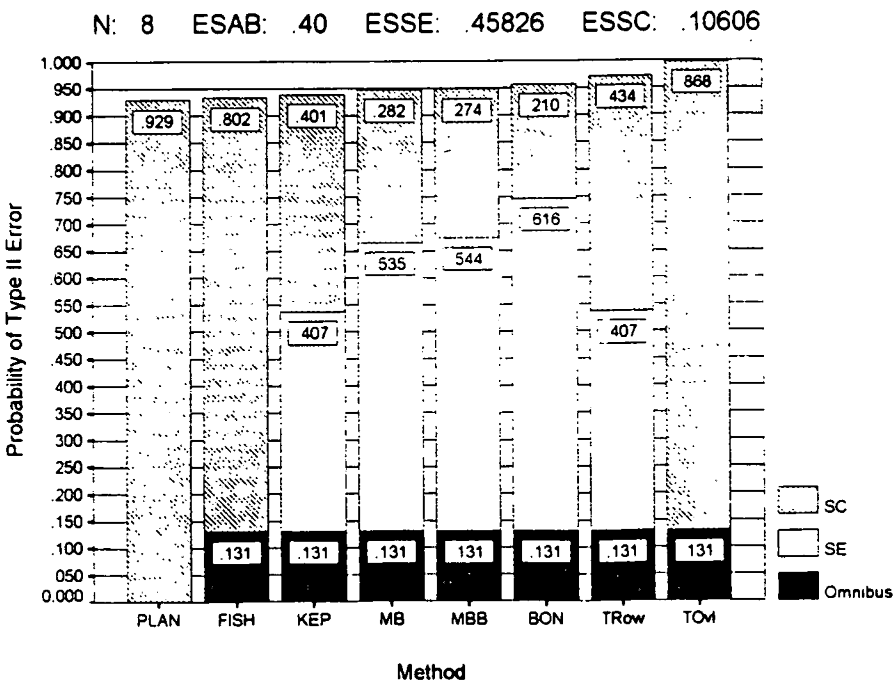
Omnibus


N: 8 ESAB: .40 ESSE: .45826 ESSC: .10606
Probability of Type II Error
Method
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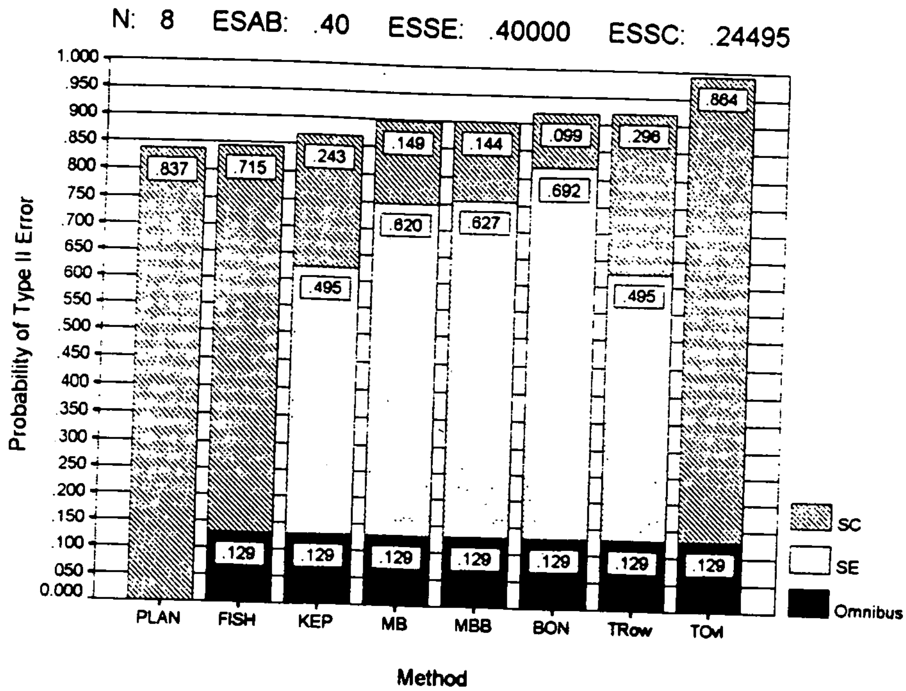
Omnibus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.243
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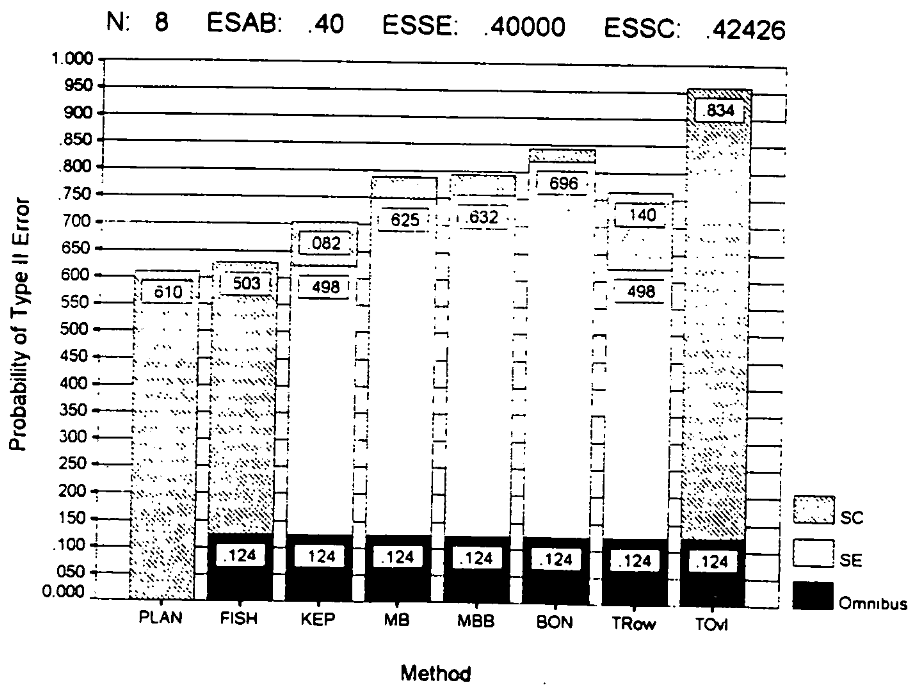
Method
SC
SE
Omnibus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Probability of Type II Error
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.100
.050
0.000
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.503
.082
.498
.625
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PLAN
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KEP
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MBB
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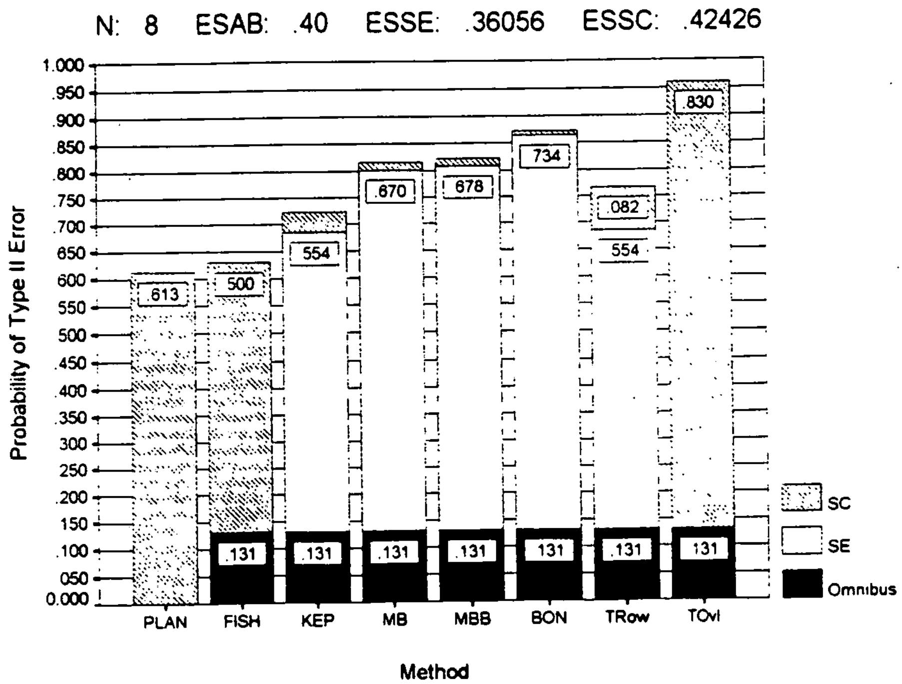
TRow
TOM
Method
SC
SE
Omnibus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Probability of Type II Error
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.450
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.250
.200
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.100
.050
0.000
.613
.500
.554
.670
.678
.734
.082
.554
.830
.131
.131
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MBB
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TOvl
Method
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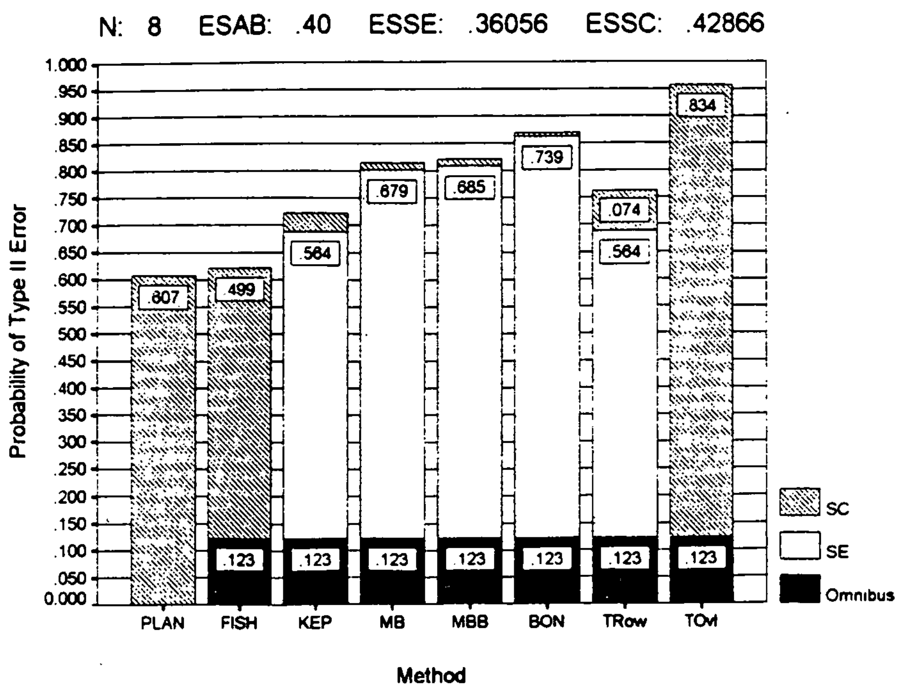
SE
Omnibus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.250
.200
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.100
.050
0.000
.607
.499
.564
.679
.685
.739
.074
.564
.834
.123
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TOvl
Method
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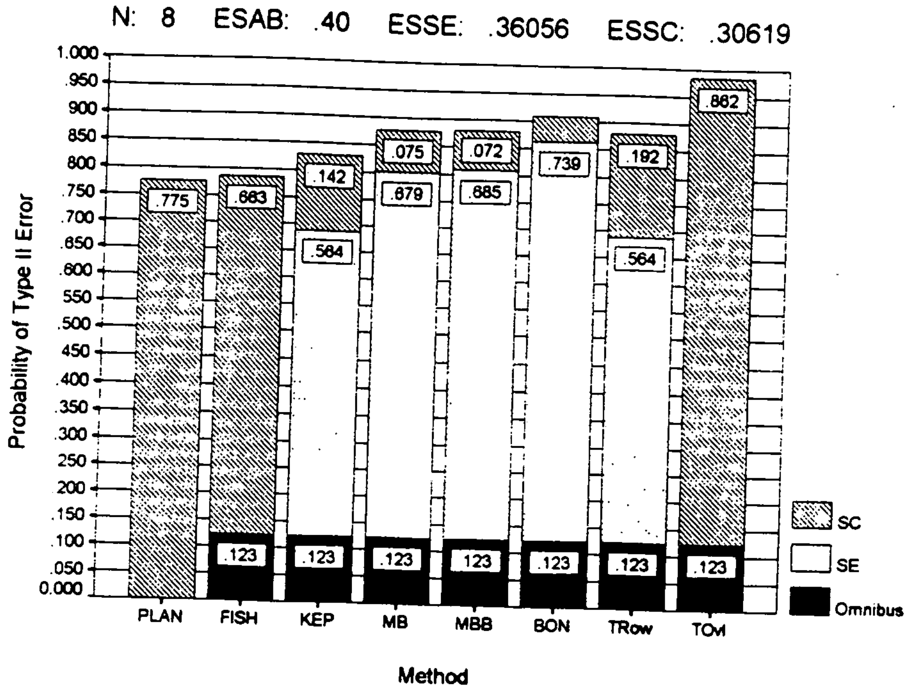
Omnibus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Method
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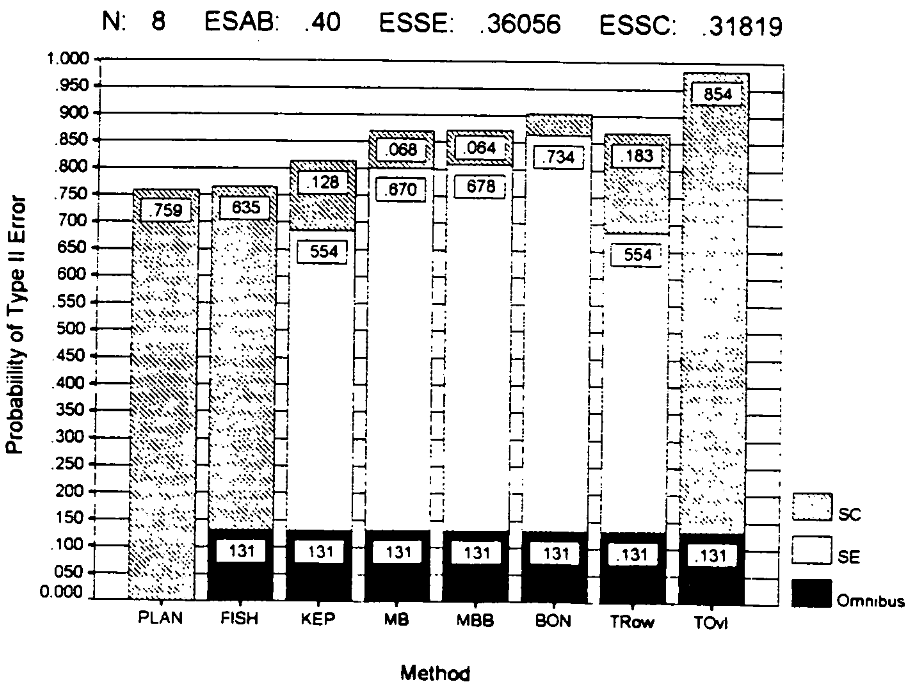
Omnibus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.050
0.000
.759
.635
.128
.554
.068
.870
.064
.678
.734
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.131
PLAN
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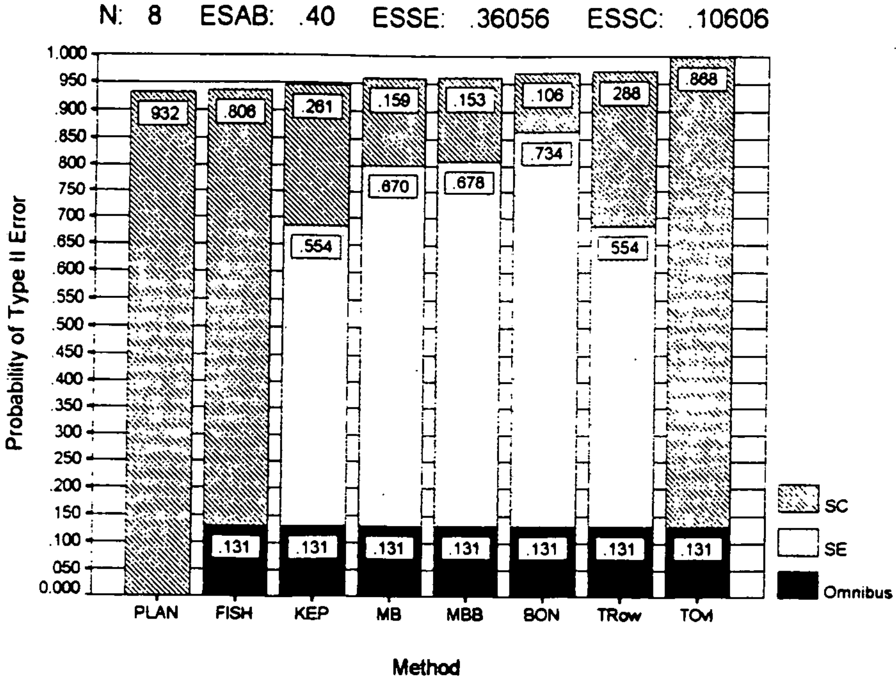
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus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.200
.150
.100
.050
0.000
932
.806
.261
.159
.153
.106
288
.868
.734
.870
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554
.131
SC
SE
Omnibus
PLAN
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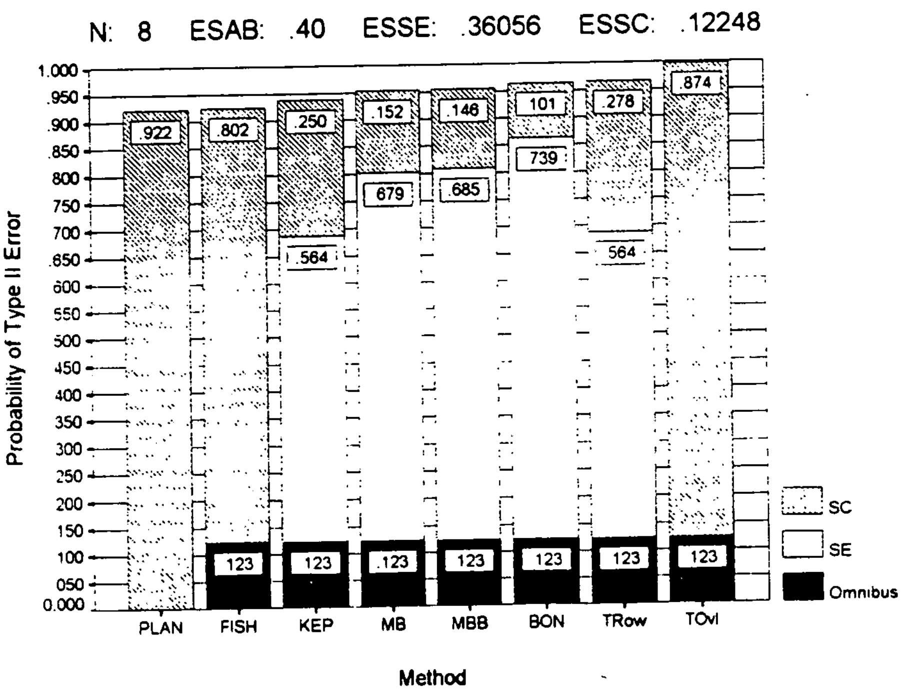
KEP
MB
MBB
BON
TRow
TCvl
Method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.200
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.100
.050
0.000
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.802
.250
.152
.146
101
.278
.874
739
679
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123
SC
SE
Omnibus
PLAN
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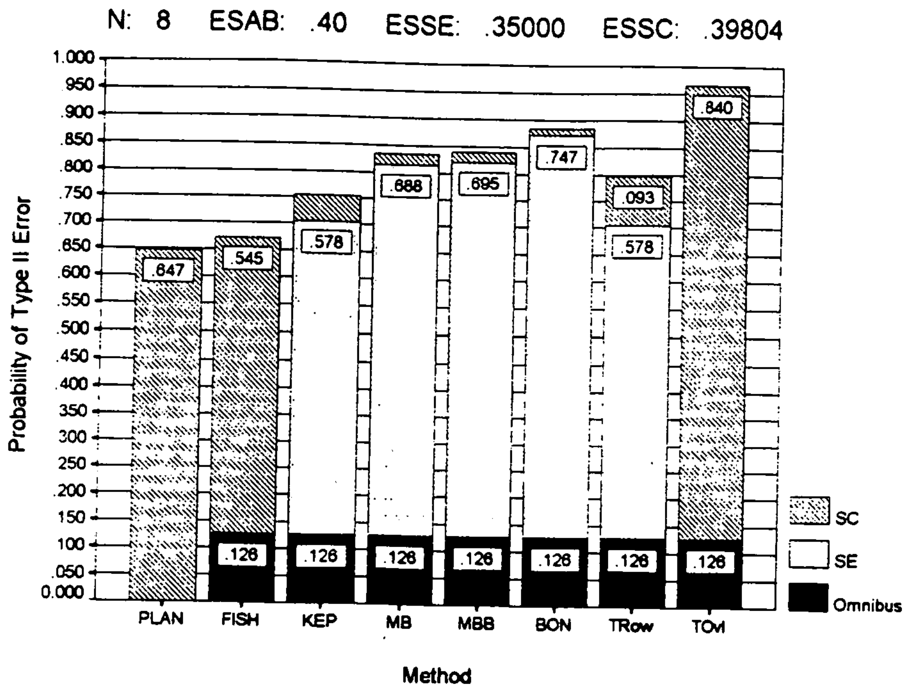
KEP
MB
MBB
BON
TRow
TCvl
Method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Probability of Type II Error
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.350
.300
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.200
.150
.100
.050
0.000
.647
.545
.578
.688
.695
.747
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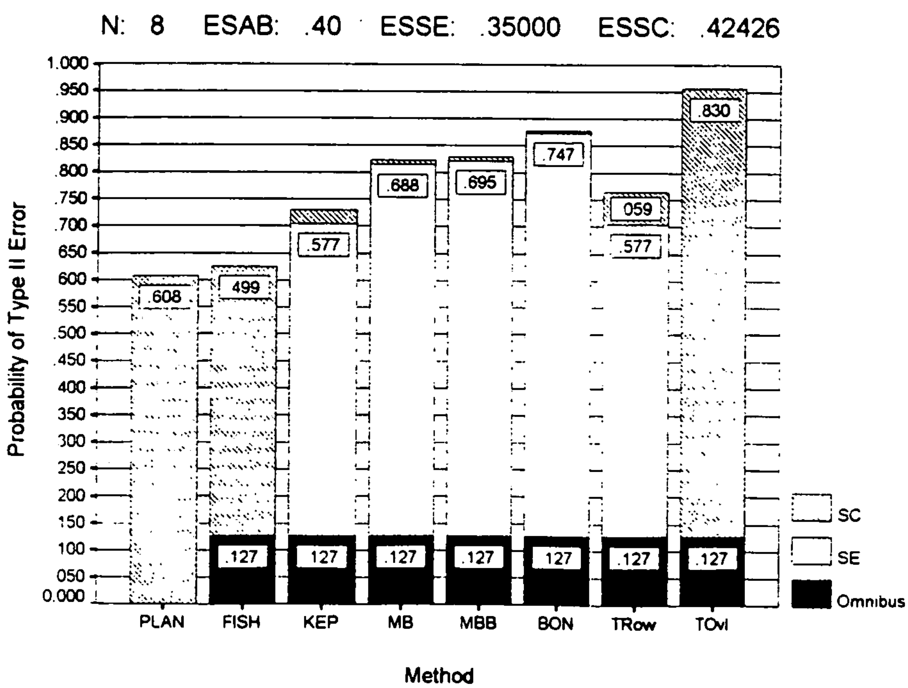
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvI
Method
SC
SE
Omnibus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Probability of Type II Error
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.450
400
350
300
250
200
150
100
050
0.000
.608
499
.577
.688
.695
.747
059
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.127
PLAN
FISH
KEP
MB
MBB
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TRow
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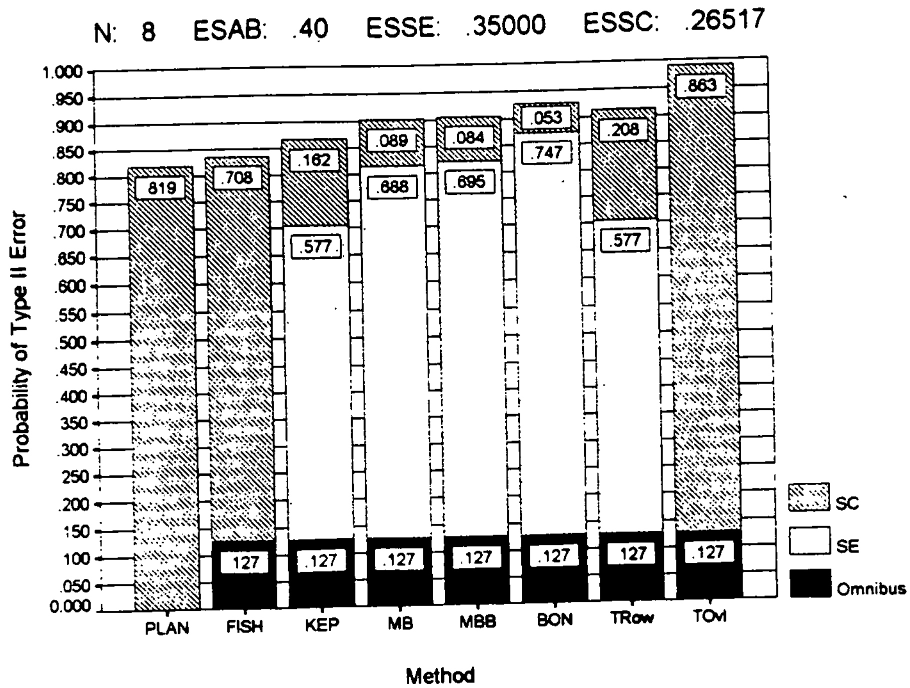
Method
SC
SE
Omnibus


N: 8 ESAB: .40 ESSE: .35000 ESSC: .26517
Probability of Type II Error
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.650
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.450
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.350
.300
.250
.200
.150
.100
.050
0.000
819
.708
.162
.577
.089
.688
.084
.695
.053
.747
.208
.577
.863
.127
.127
.127
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.127
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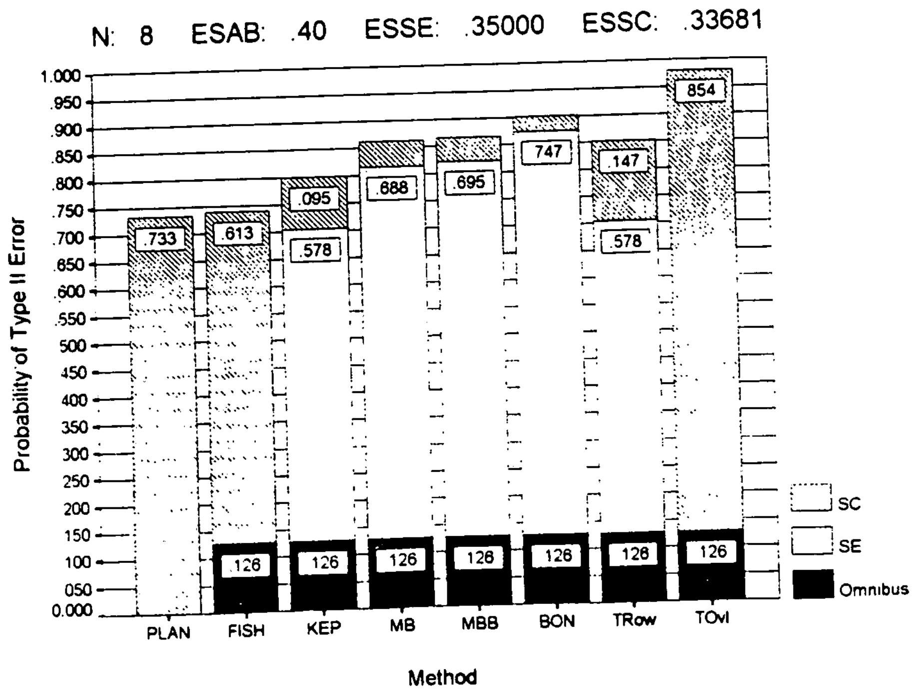
.127
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOVI
Method
SC
SE
Omnibus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Probability of Type II Error
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.500
.450
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.350
.300
.250
.200
.150
.100
.050
0.000
.733
.613
.095
.578
.688
.695
.747
.147
.578
854
.126
.126
.126
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.126
PLAN
FISH
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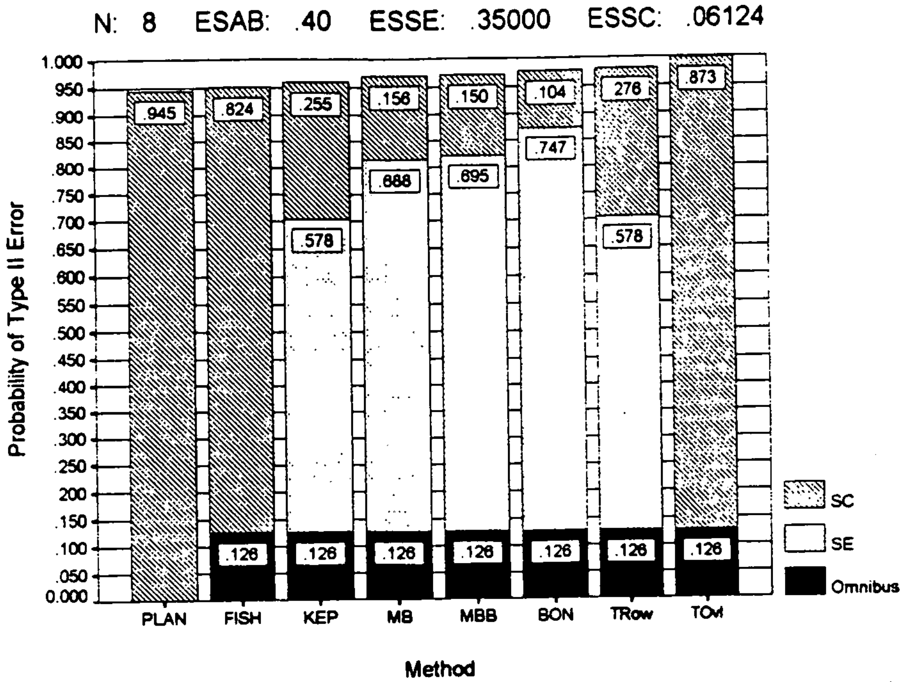
MB
MBB
BON
TRow
TOVI
Method
SC
SE
Omnibus


N: 8 ESAB: .40 ESSE: .35000 ESSC: .06124
Probability of Type II Error
Method
PLAN FISH KEP MB MBB BON TRow TOM
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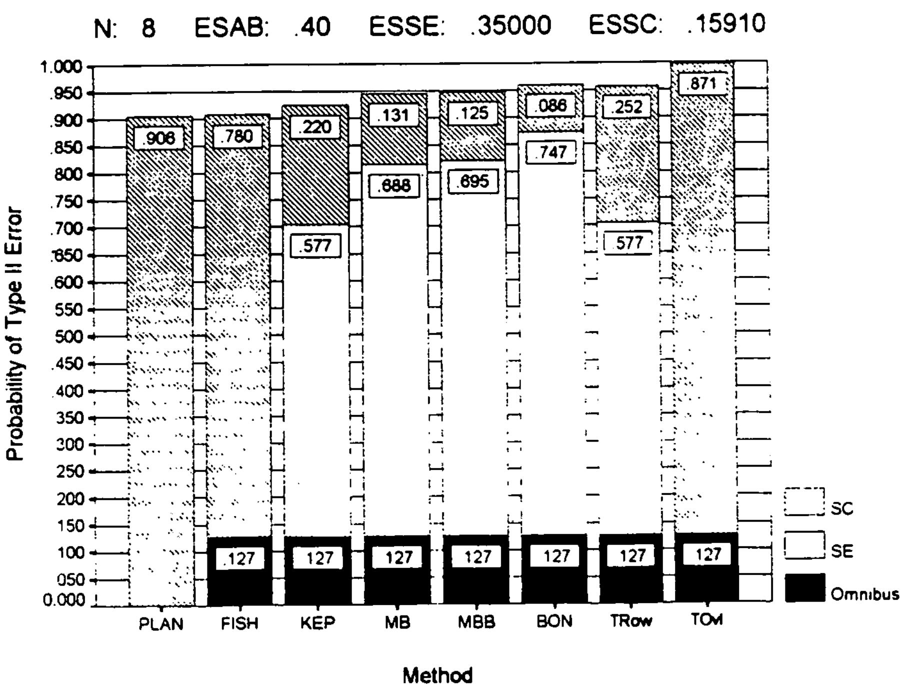
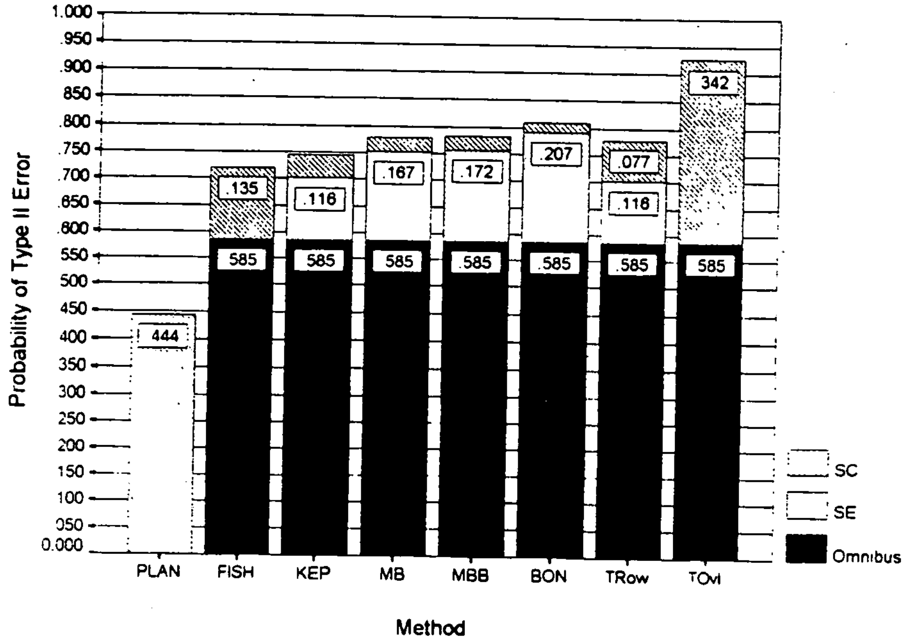
.578 .688 .695 .747 .578
.126 .126 .126 .126 .126 .126 .126
SC
SE
Omnibus


N: 8 ESAB: .40 ESSE: .35000 ESSC: .15910
Probability of Type II Error
Method
PLAN FISH KEP MB MBB BON TRow TOM
.906 .780 .220 .131 .125 .086 .252 .871
.577 .688 .695 .747 .577
.127 127 127 127 127 127 127
SC
SE
Omnibus

N: 8 ESAB: .25 ESSE: .50000 ESSC: .53032



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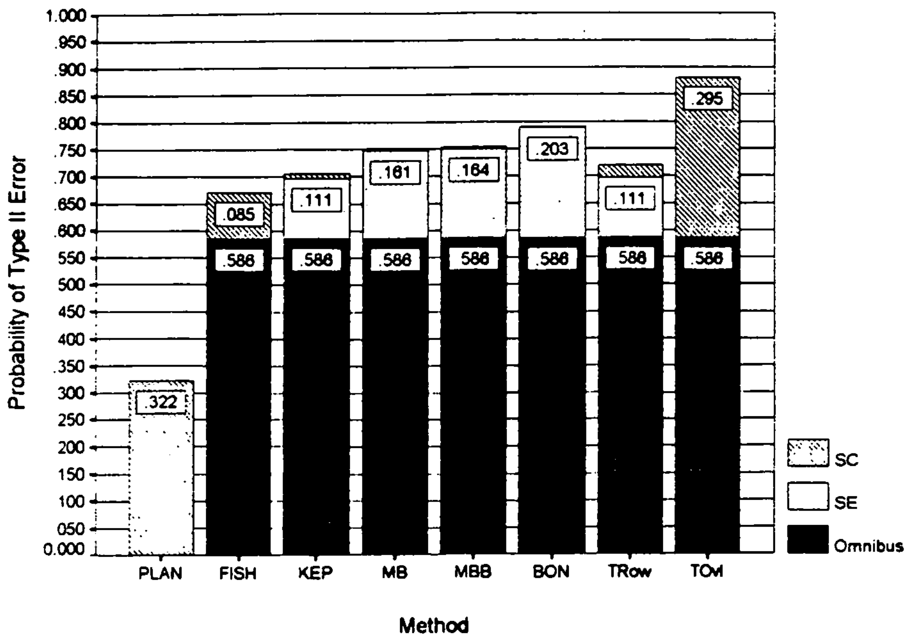

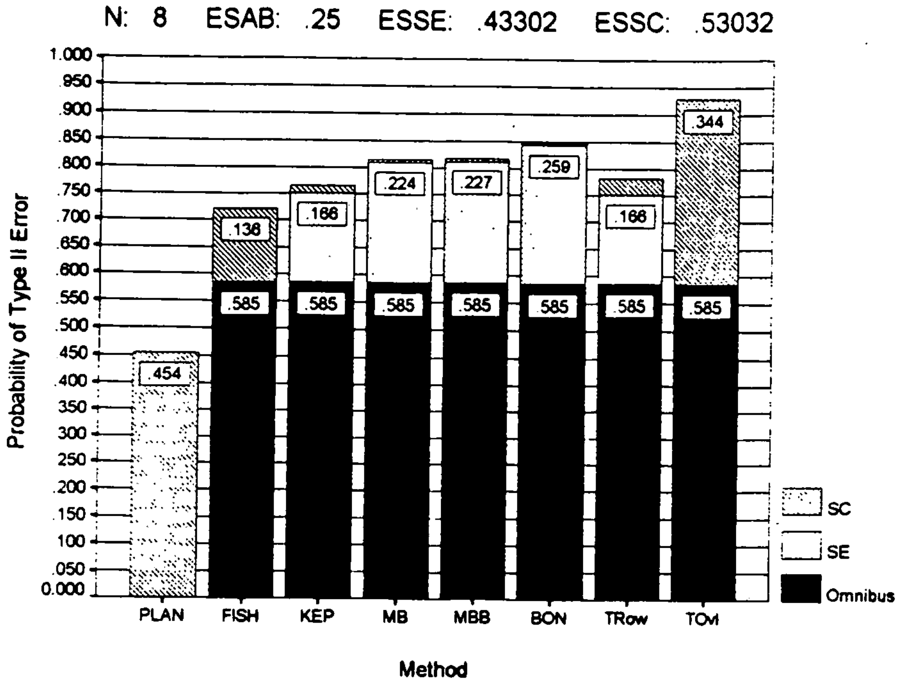
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Probability of Type II Error
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.750
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.600
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.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.454
.585
.138
.166
.224
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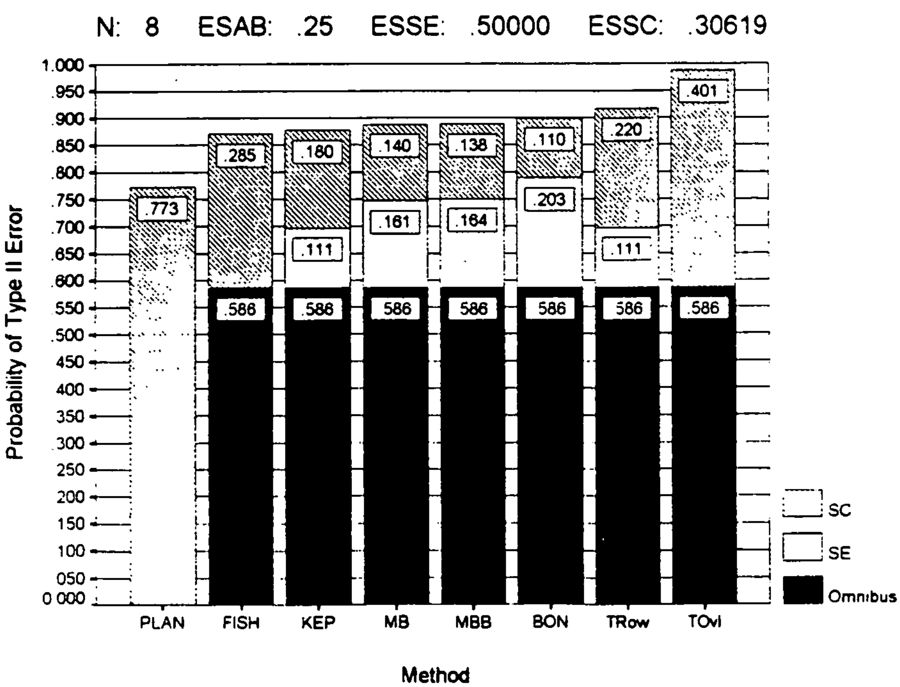
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOvl
Method
SC
SE
Omnibus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Probability of Type II Error
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.300
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.200
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.050
0.000
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.586
.285
.180
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.140
.161
.138
.164
.110
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TOvl
Method
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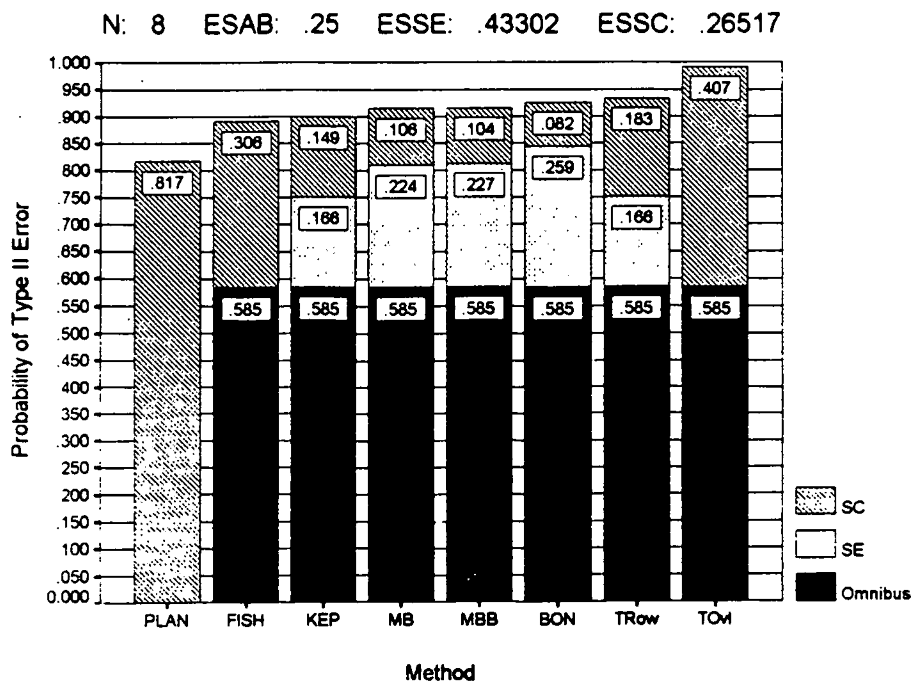
SE
Omnibus


N: 8 ESAB: .25 ESSE: .43302 ESSC: .26517
Probability of Type II Error
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.250
.200
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.100
.050
0.000
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Method
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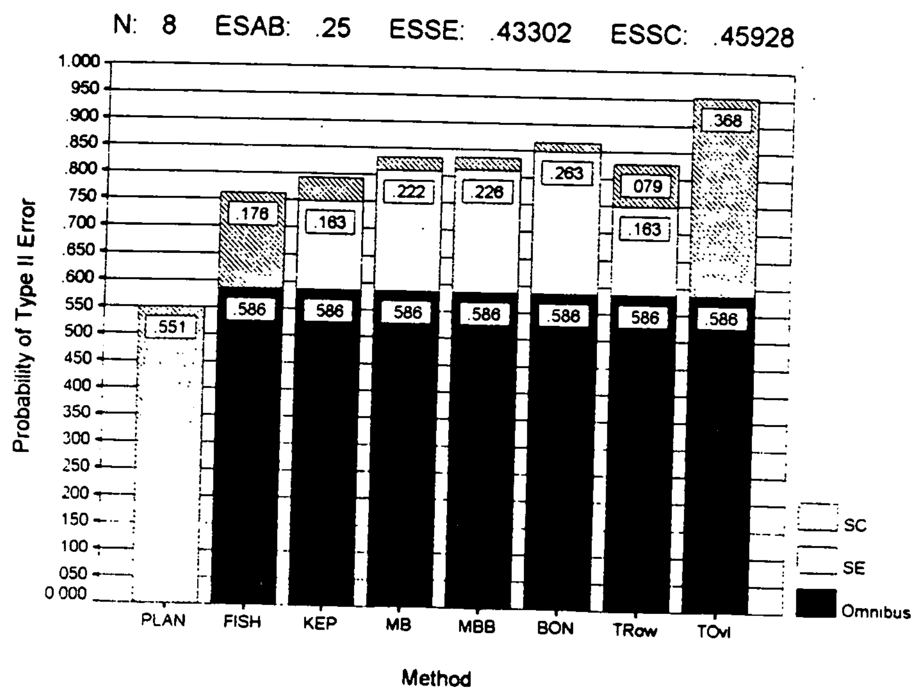
SE
Omnibus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.200
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.100
.050
0.000
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.226
.263
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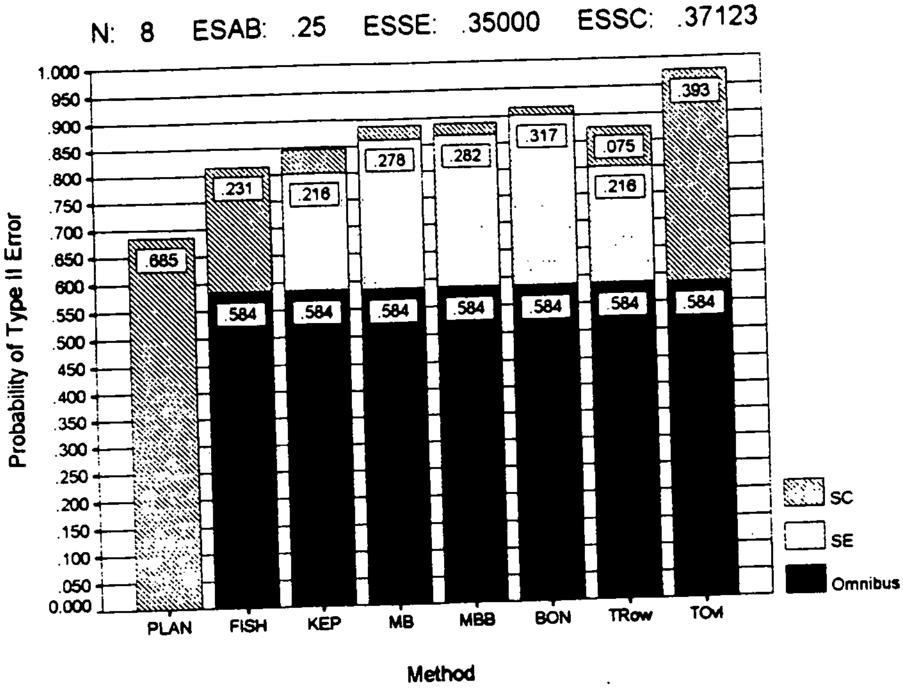
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0.000
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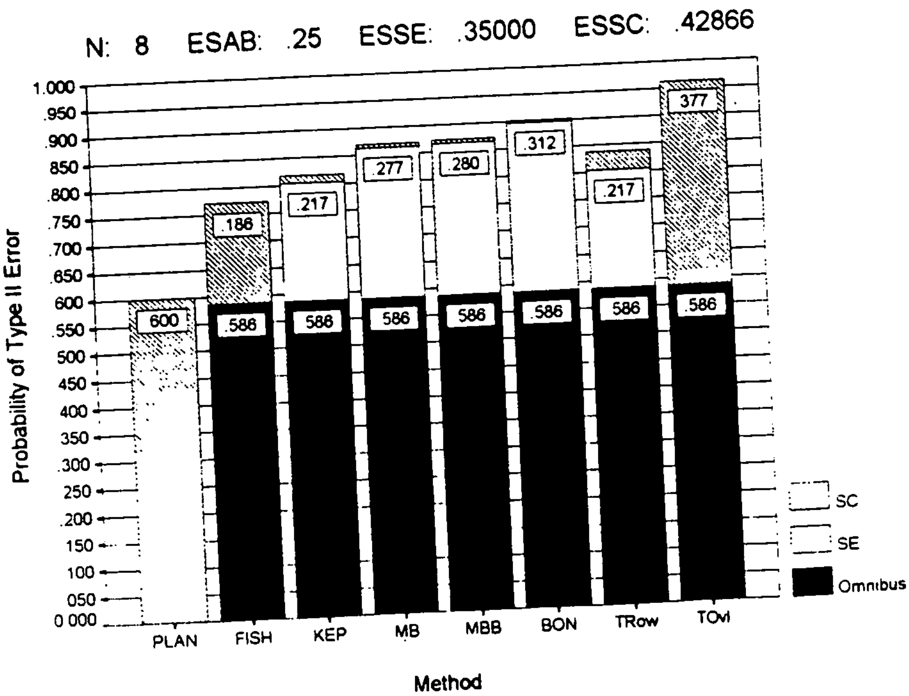
Omnibus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Probability of Type II Error
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100
050
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600
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377
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PLAN
FISH
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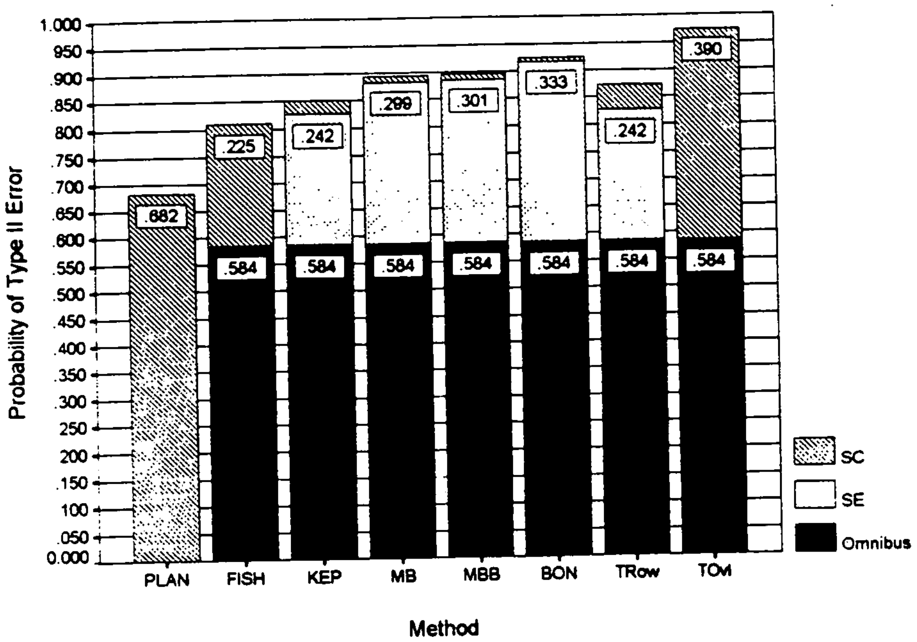
BON
TRow
TOM
Method
SC
SE
Omnibus

N: 8 ESAB: .25 ESSE: .31225 ESSC: .37123



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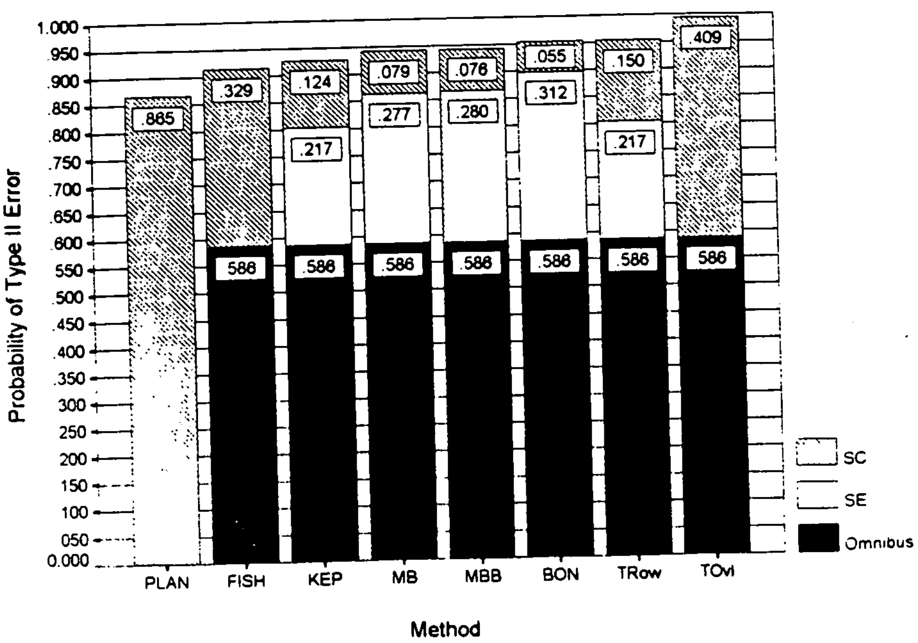

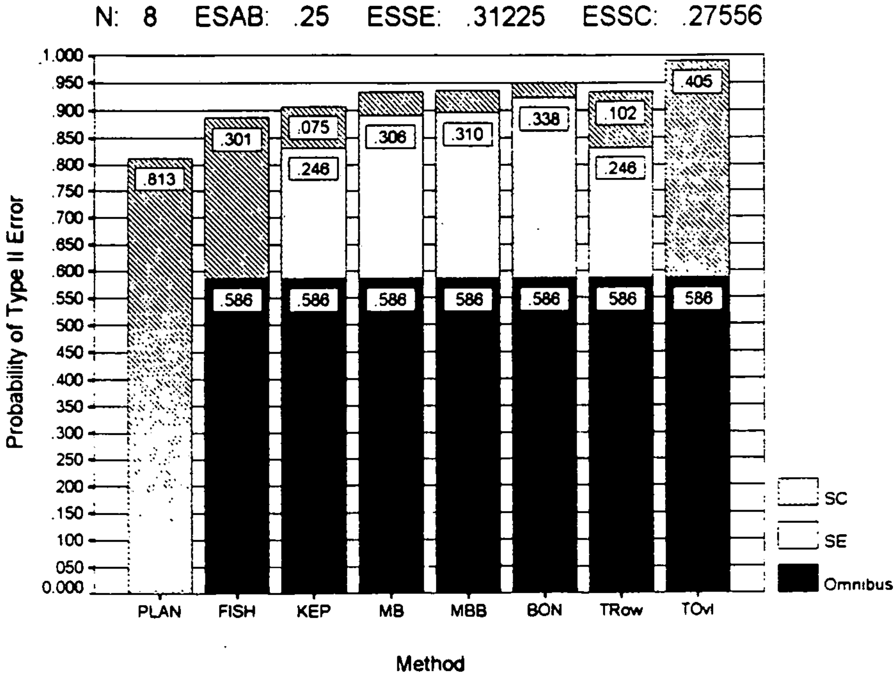
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Probability of Type II Error
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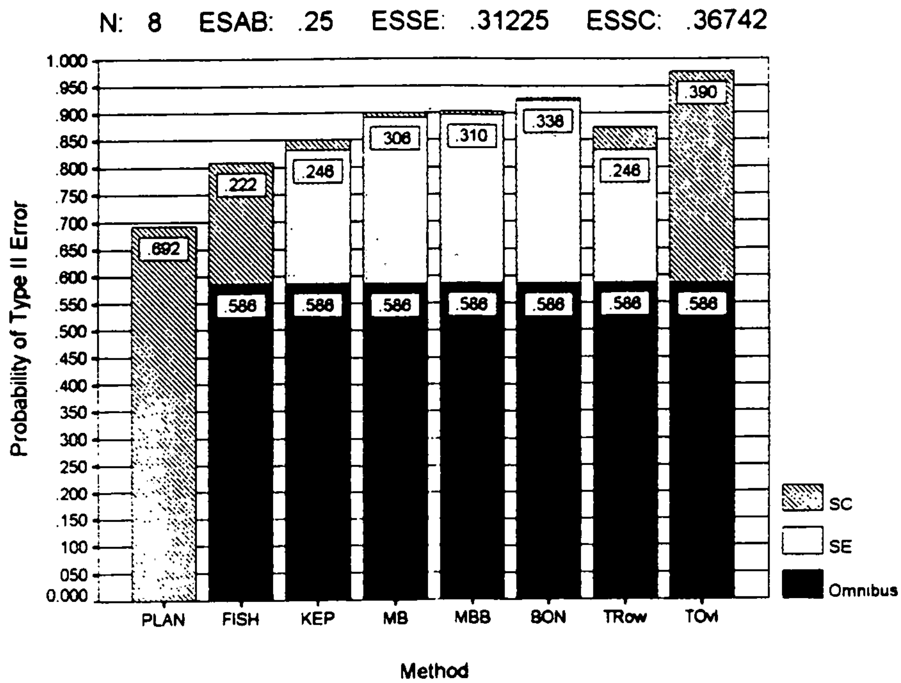
Omnibus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.050
0.000
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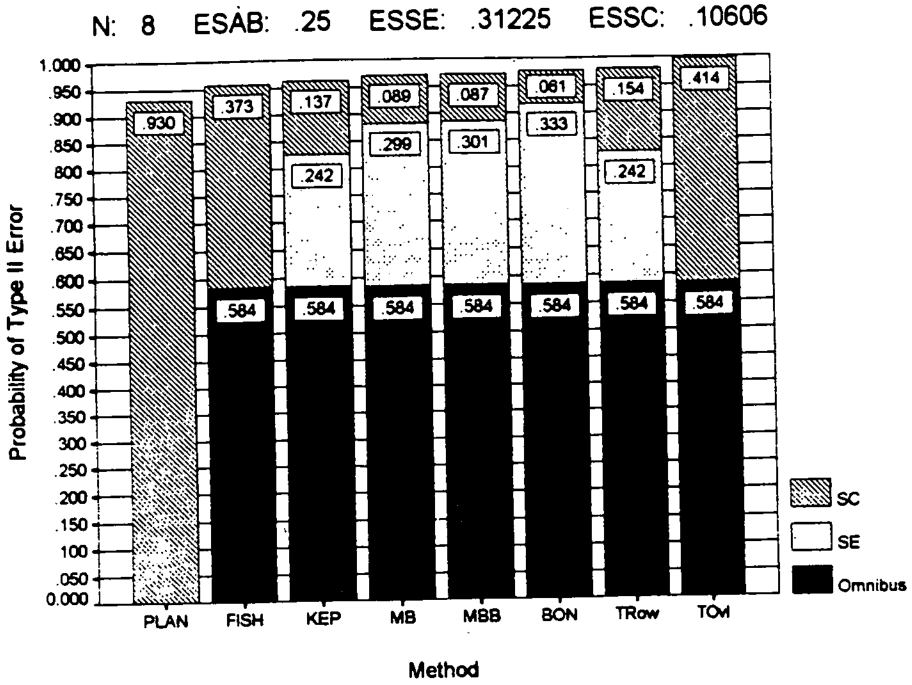
Omnibus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Probability of Type II Error
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TOM
Method
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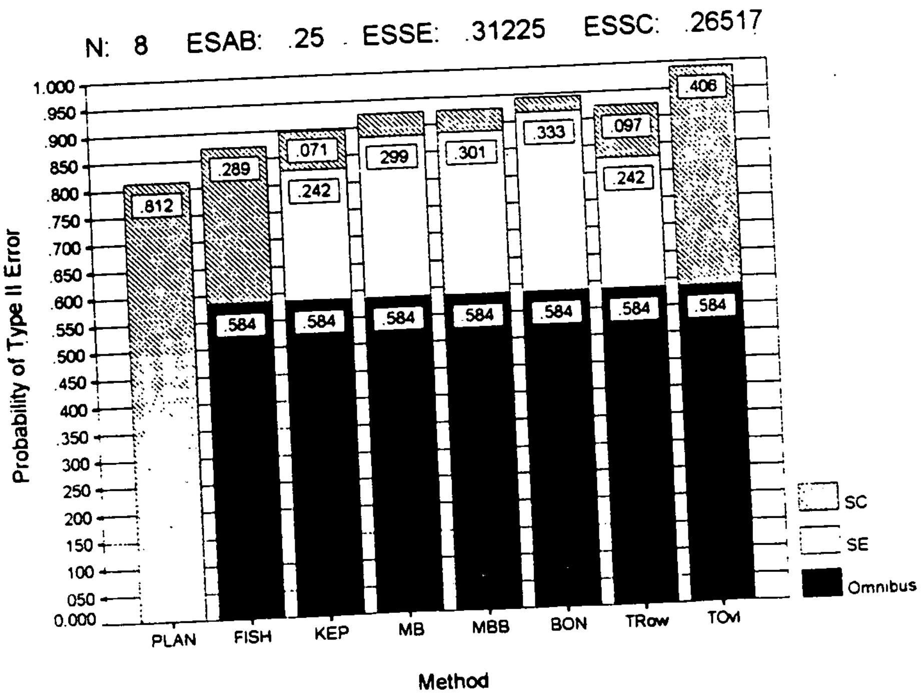
SE
Omnibus


N: 8 ESAB: .25 ESSE: .31225 ESSC: .26517
Probability of Type II Error
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SC
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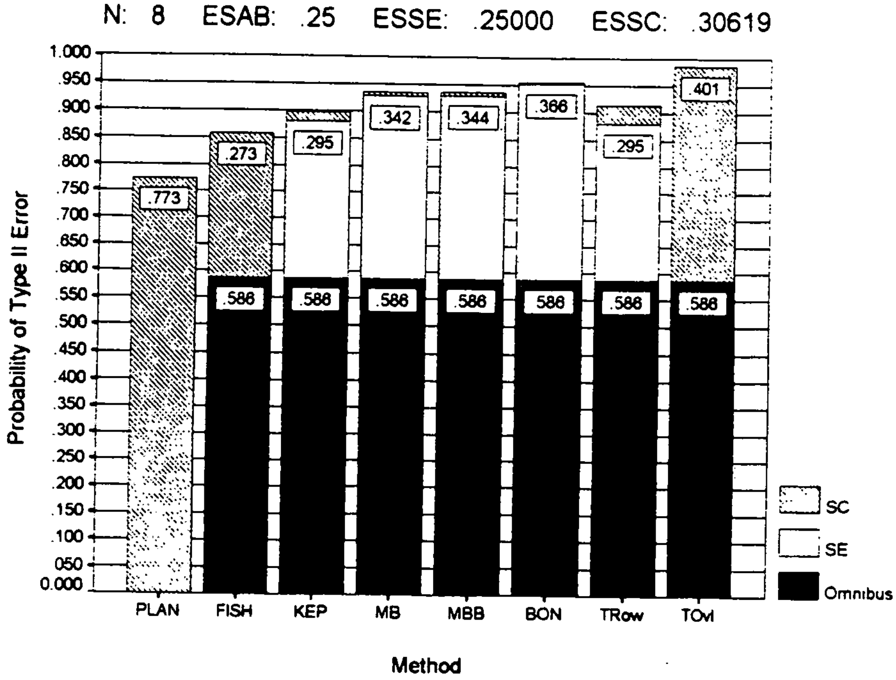
Omnibus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Probability of Type II Error
Method
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KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus
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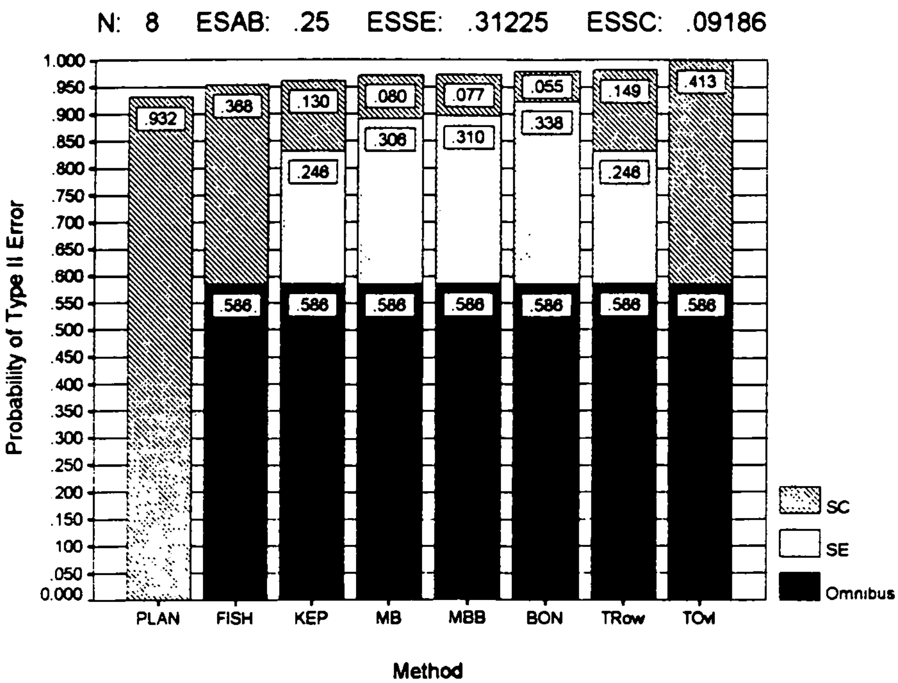
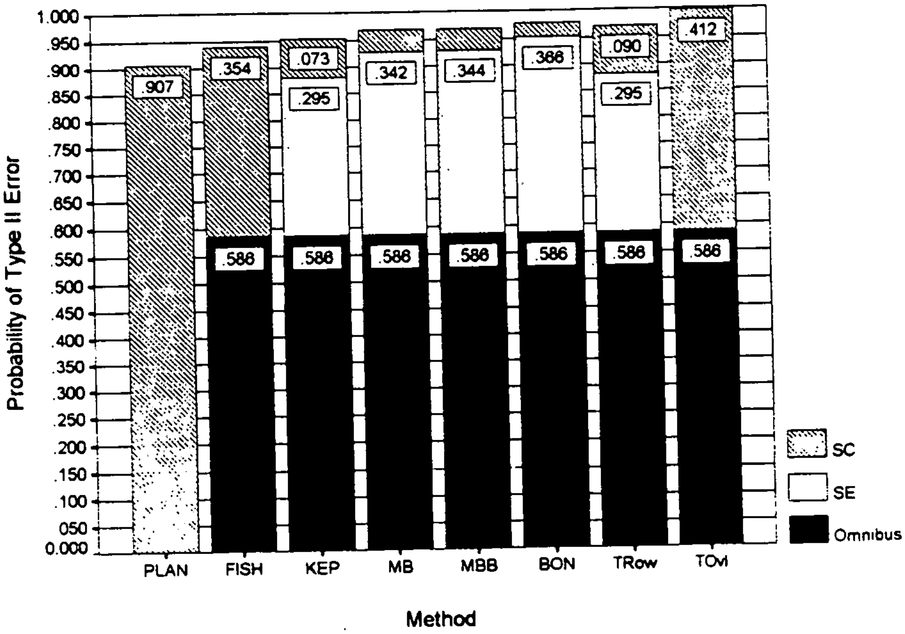
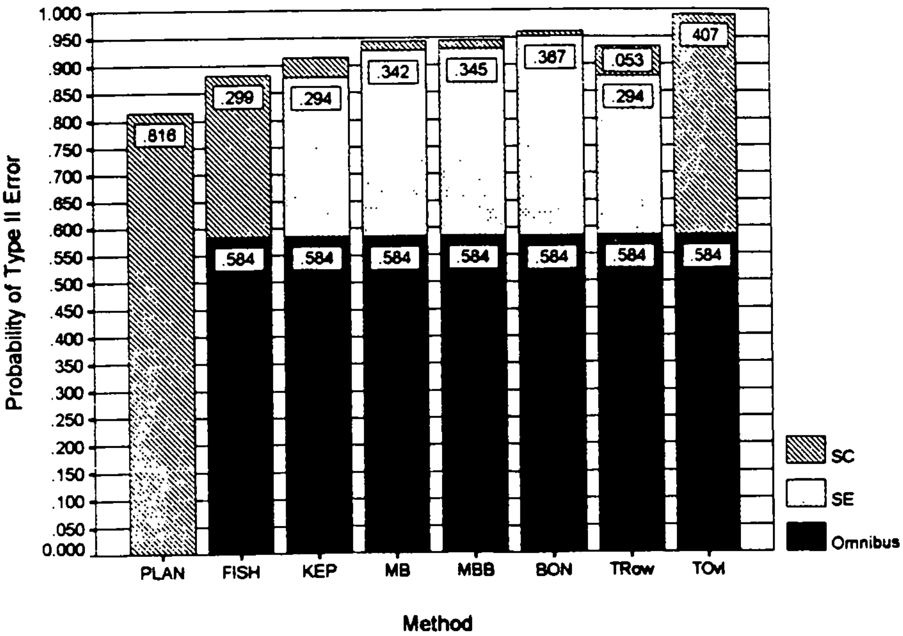
.366
.295
.401
.586

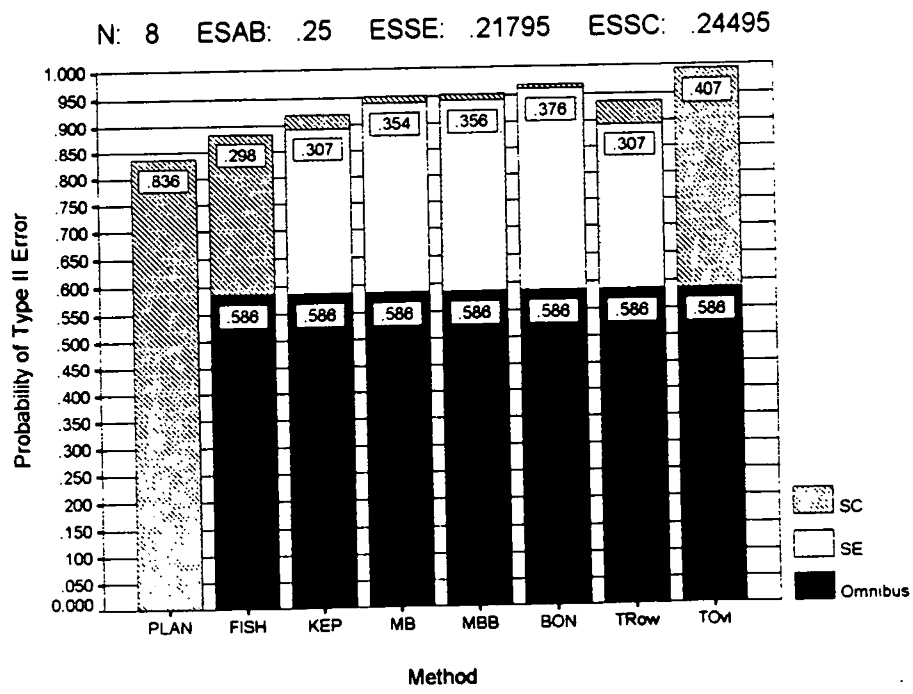

N: 8 ESAB: .25 ESSE: .31225 ESSC: .09186
Probability of Type II Error
Method
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
SC
SE
Omnibus
.932
.368
.130
.248
.080
.306
.077
.310
.055
.338
.149
.248
.413
.586

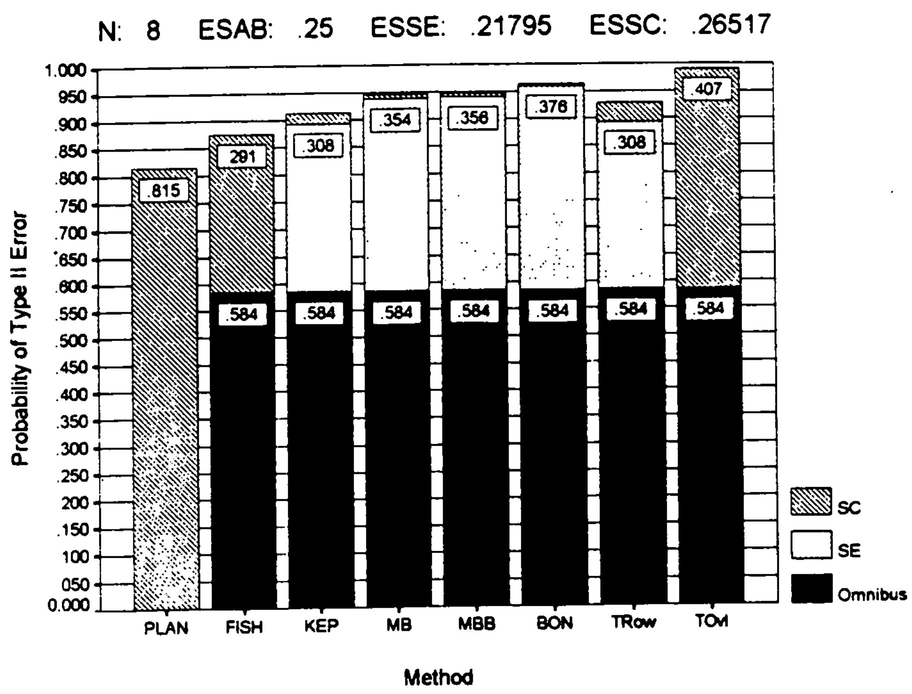
N: 8 ESAB: .25 ESSE: .25000 ESSC: .15309

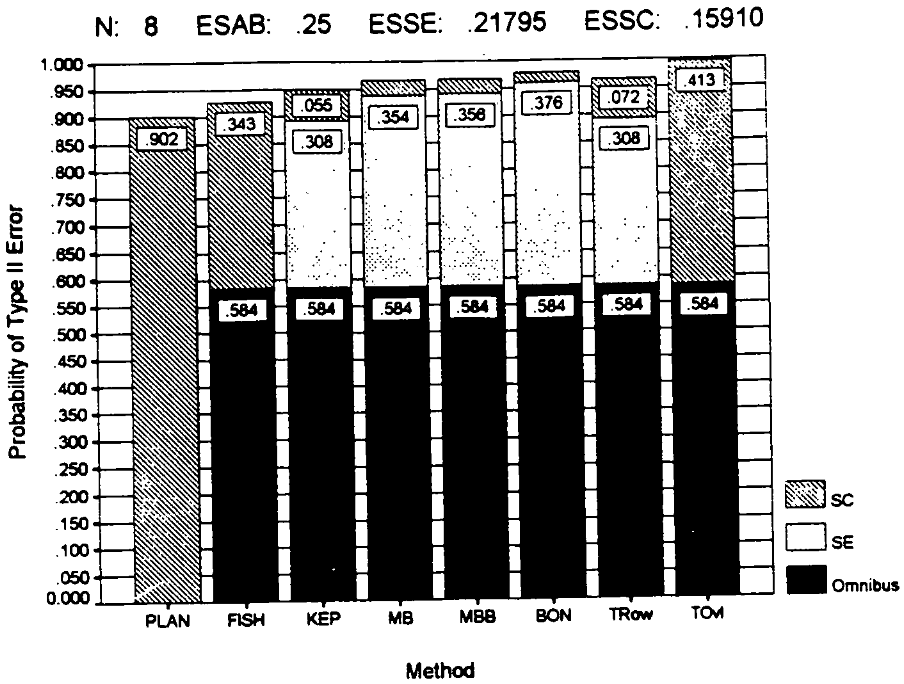


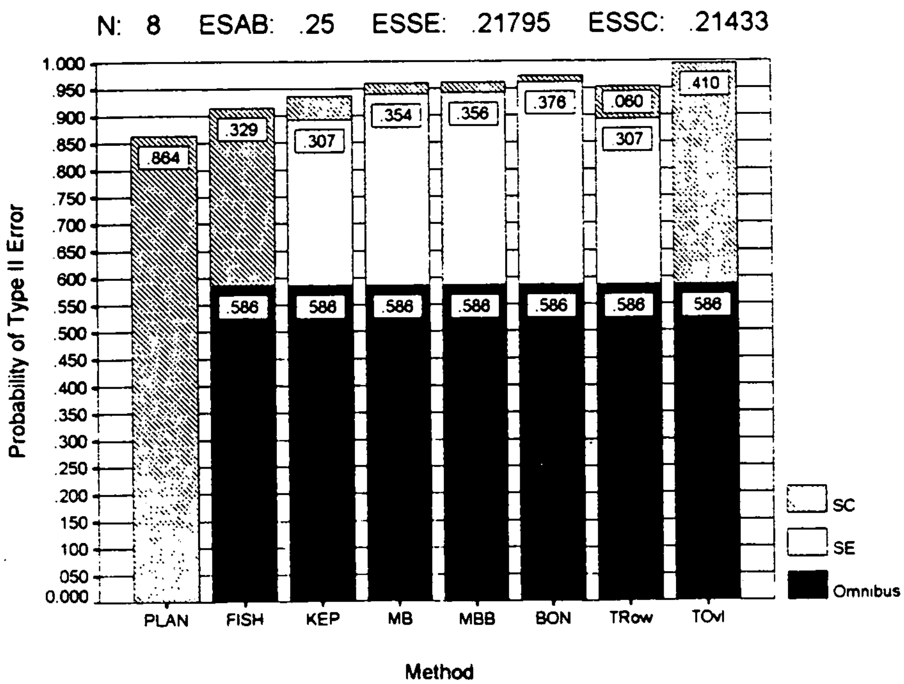
N: 8 ESAB: .25 ESSE: .25000 ESSC: .26517

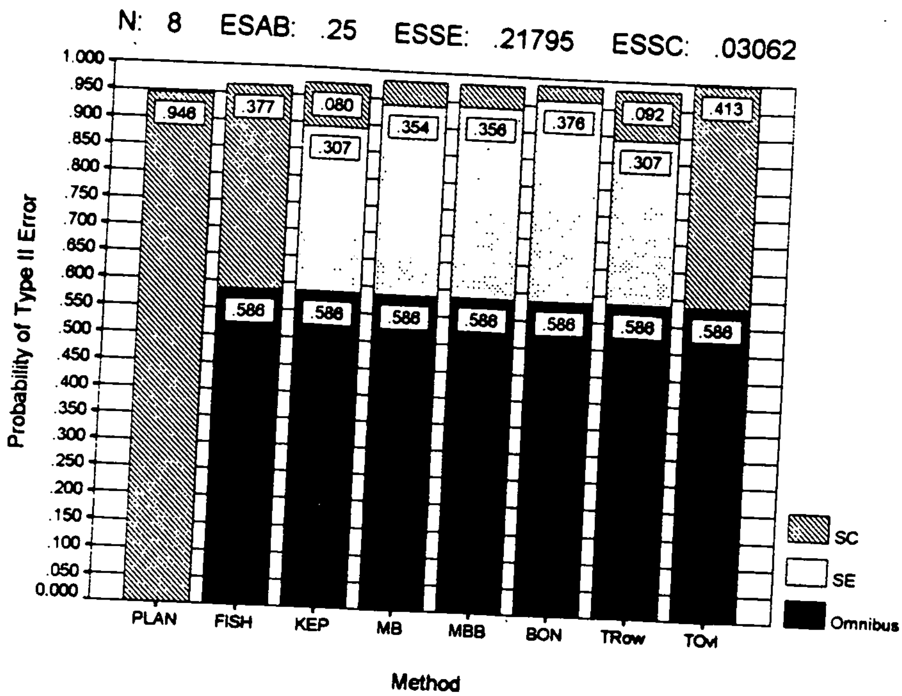


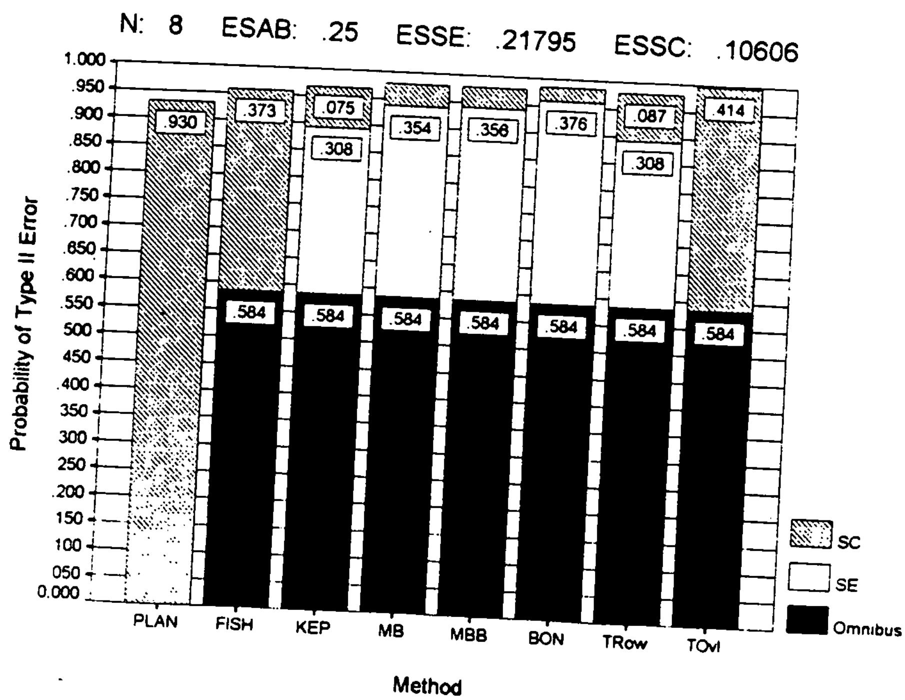

N: 8 ESAB: .25 ESSE: .21795 ESSC: .24495
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.836
.298
.307
.354
.356
.376
.307
.407
.586
.586
.586
.586
.586
.586
.586
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .25 ESSE: .21795 ESSC: .26517
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.815
.291
.308
.354
.356
.376
.308
.407
.584
.584
.584
.584
.584
.584
.584
PLAN
FISH
KEP
MB
MBB
BON
TRow
TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .25 ESSE: .21795 ESSC: .15910
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.902
.343
.055
.308
.354
.356
.376
.072
.308
.413
.584
.584
.584
.584
.584
.584
.584
PLAN FISH KEP MB MBB BON TRow TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .25 ESSE: .21795 ESSC: .21433
Probability of Type II Error
1.000
.950
.900
.850
.800
.750
.700
.650
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.050
0.000
.864
.329
.307
.354
.356
.376
.060
.307
.410
.586
.586
.586
.586
.586
.586
.586
PLAN FISH KEP MB MBB BON TRow TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .25 ESSE: .21795 ESSC: .03062
Probability of Type II Error
.946
.377
.080
.307
.354
.356
.376
.092
.307
.413
.586
PLAN FISH KEP MB MBB BON TRow TOM
Method
SC
SE
Omnibus


N: 8 ESAB: .25 ESSE: .21795 ESSC: .10606
Probability of Type II Error
.930
.373
.075
.308
.354
.356
.376
.087
.308
.414
.584
PLAN FISH KEP MB MBB BON TRow TOM
Method
SC
SE
Omnibus

APPENDIX C:

FIGURES C1 - C180

TYPE II ERROR AT

EACH LEVEL OF ANALYSIS

CONDITION 7: ESa=moderate, ESab=moderate, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.35355	0.17677	0.17678	0.25000
B2	0.17677	-0.35355	0.17678	0.25000
B3	-0.35355	-0.35355	0.70710	0.50000
B4	-0.53033	0	0.53033	0.43302
B5	0.17677	-0.35355	0.17678	0.25000

CONDITION 8: ESa=moderate, ESab=large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.45962	-0.45962	0.91923	0.65000
B2	-0.45962	0.38890	0.07071	0.35000
B3	0.38890	-0.45962	0.07071	0.35000
B4	-0.74246	0.10606	0.63639	0.56789
B5	0.38890	-0.45962	0.07071	0.35000

CONDITION 9: ESa=moderate, ESab=very large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.60104	-0.60104	1.20207	0.84999
B2	-0.60104	0.60104	-0.07071	0.52201
B3	0.67174	-0.60104	-0.07071	0.52201
B4	1.02530	0.24748	0.77781	0.75664
B5	0.67174	-0.60104	-0.07071	0.52201

CONDITION 4: ESa=small, ESab=moderate, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.24749	0.28284	-0.03536	0.21794
B2	0.28284	-0.24749	-0.03536	0.21794
B3	-0.24749	-0.24749	0.49497	0.35000
B4	-0.42426	0.10607	0.31820	0.31225
B5	0.28284	-0.24749	-0.03536	0.21794

CONDITION 5: ESa=small, ESab=large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.35355	-0.35355	0.70710	0.50000
B2	-0.35355	0.49497	-0.14142	0.36055
B3	0.49497	-0.35355	-0.14142	0.36055
B4	-0.63639	0.21213	0.42426	0.45825
B5	0.49497	-0.35355	-0.14142	0.36055

CONDITION 6: ESa=small, ESab=very large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.49497	-0.49497	0.98994	0.69999
B2	-0.49497	0.77781	-0.28284	0.55677
B3	0.77781	-0.49497	-0.28284	0.55677
B4	-0.91923	0.35355	0.56568	0.65574
B5	0.77781	-0.49497	-0.28284	0.55677

CONDITION 1: ESa=null, ESab=moderate, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.17678	0.35355	-0.17678	0.25000
B2	0.35355	-0.17678	-0.17678	0.25000
B3	-0.17678	-0.17678	0.35355	0.25000
B4	-0.35355	0.17678	0.17678	0.25000
B5	0.35355	-0.17678	-0.17678	0.25000

CONDITION 2: ESa=null, ESab=large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.28284	-0.28284	0.56568	0.40000
B2	-0.28284	0.56568	-0.28284	0.40000
B3	0.56568	-0.28284	-0.28284	0.40000
B4	-0.56568	0.28284	0.28284	0.40000
B5	0.56568	-0.28284	-0.28284	0.40000

CONDITION 3: ESa=null, ESab=very large, Maximum Variability				
	A1	A2	A3	ESSE
B1	-0.42426	-0.42426	0.84852	0.59999
B2	-0.42426	0.84852	-0.42426	0.59999
B3	0.84852	-0.42426	-0.42426	0.59999
B4	-0.84852	0.42426	0.42426	0.59999
B5	0.84852	-0.42426	--0.42426	0.59999

CONDITION 7: ESa=moderate, ESab=moderate, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.61238	0	0.61238	0.50001
B2	-0.30619	0.30619	0	0.25000
B3	0	-0.30619	0.30619	0.25000
B4	-0.30619	-0.30619	0.61238	0.43302
B5	-0.30619	0.30619	0	0.25000

CONDITION 8: ESa=moderate, ESab=large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.79609	0	0.79609	0.65000
B2	-0.30619	0.48990	-0.18371	0.35000
B3	0.18371	-0.48990	0.30619	0.35000
B4	-0.30619	-0.48990	0.79609	0.56789
B5	-0.30619	0.48990	-0.18371	0.35000

CONDITION 9: ESa=moderate, ESab=very large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-1.04104	0	1.04104	0.85001
B2	-0.30619	0.73485	-0.42866	0.52202
B3	0.42866	-0.73485	0.30619	0.52202
B4	-0.30619	-0.73485	1.04104	0.75664
B5	-0.30619	0.73485	-0.42866	0.52202

CONDITION 4: ESa=small, ESab=moderate, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.42866	0	0.42866	0.35000
B2	-0.12247	0.30619	-0.18372	0.21795
B3	0.18372	-0.30619	0.12247	0.21795
B4	-0.12247	-0.30619	0.42866	0.31225
B5	-0.12247	0.30619	-0.18372	0.21795

CONDITION 5: ESa=small, ESab=large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.61237	0	0.61237	0.50000
B2	-0.12247	0.48990	-0.36743	0.36056
B3	0.36743	-0.48990	0.12247	0.36056
B4	-0.12247	-0.48990	0.61237	0.45826
B5	-0.12247	0.48990	-0.36743	0.36056

CONDITION 6: ESa=small, ESab=very large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.85732	0	0.85732	0.70000
B2	-0.12247	0.73485	-0.61238	0.55678
B3	0.61238	-0.73485	0.12247	0.55678
B4	-0.12247	-0.73485	0.85732	0.65574
B5	-0.12247	0.73485	-0.61238	0.55678

CONDITION 1: ESa=null, ESab=moderate, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.30619	0	0.30619	0.25000
B2	0	0.30619	-0.30619	0.25000
B3	0.30619	-0.30619	0	0.25000
B4	0	-0.30619	0.30619	0.25000
B5	0	0.30619	-0.30619	0.25000

CONDITION 2: ESa=null, ESab=large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.48990	0	0.48990	0.40000
B2	0	0.48990	-0.48990	0.40000
B3	0.48990	-0.48990	0	0.40000
B4	0	-0.48990	0.48990	0.40000
B5	0	0.48990	-0.48990	0.40000

CONDITION 3: ESa=null, ESab=very large, Minimum Variability				
	A1	A2	A3	ESSE
B1	-0.73485	0	0.73485	0.60000
B2	0	0.73485	-0.73485	0.60000
B3	0.73485	-0.73485	0	0.60000
B4	0	-0.73485	0.73485	0.60000
B5	0	0.73485	-0.73485	0.60000

APPENDIX B

EFFECT SIZE MATRICES

```
(*          An error in the input arguments results in a returned      *)
(*           probability of -1.                                        *)
(*                                                                     *)
(*---------------------------------------------------------------------*)

CONST
   Dprec   = 12;
   MaxIter = 200;

VAR
   Iter:   INTEGER;
   Cprec:  REAL;
   Ifault: INTEGER;
   Pval:   REAL;

BEGIN (* SigF *)

   Pval := -1.0;

   IF ( Dfn > 0.0 ) AND ( Dfd > 0.0 ) THEN
      BEGIN
        Pval := CDBeta( Dfd / ( Dfd + F * Dfn ), Dfd / 2.0, Dfn / 2.0,
                        Dprec, MaxIter, Cprec, Iter, Ifault );
        IF Ifault <> 0 THEN Pval := -1.0;
      END;

   SigF := Pval;

END  (* SigF *);
```

```
        IF ABS( Bhi ) < Rsmall THEN Bhi := 0.0;

        IF( Bhi <> 0.0 ) THEN
           BEGIN
              F      := Ahi / Bhi;
              Qconv  := ( ABS( ( F - Fx ) / F ) < Epsz );
           END;

        Iter  := Iter + 1;

     UNTIL ( ( Iter > MaxIter ) OR Qconv ) ;
                                       (* Arrive here when convergence    *)
                                       (* achieved, or maximum iterations *)
                                       (* exceeded.                       *)

  IF ( Qswap ) THEN
     CDBeta := 1.0 - F
  ELSE
     CDBeta := F;
                                       (* Calculate precision of result *)

  IF ABS( F - Fx ) <> 0.0 THEN
     Cprec := -LogTen( ABS( F - Fx ) )
  ELSE
     Cprec := MaxPrec;

9000:  (* Error exit *)

END   (* CDBeta *);


(*-----------------------------------------------------------------------*)
(*              SigF  -- Significance of F distribution                  *)
(*-----------------------------------------------------------------------*)

FUNCTION SigF( F , Dfn , Dfd : REAL ) : REAL;

(*-----------------------------------------------------------------------*)
(*                                                                       *)
(*      Function:  SigF                                                  *)
(*                                                                       *)
(*      Purpose:   Evaluates F distribution probability                  *)
(*                                                                       *)
(*      Calling Sequence:                                                *)
(*                                                                       *)
(*           P     := SigF( F , Dfn , Dfd );                             *)
(*                                                                       *)
(*                F      --- F-value                                     *)
(*                Dfn    --- Numerator degrees of freedom                *)
(*                Dfd    --- Denominator degrees of freedom              *)
(*                                                                       *)
(*                P      --- Resultant probability                       *)
(*                                                                       *)
(*      Calls:                                                           *)
(*                                                                       *)
(*           CdBeta                                                      *)
(*                                                                       *)
(*      Method:                                                          *)
(*                                                                       *)
(*           The input values are transformed to match the               *)
(*           requirements of the Beta distribution.  Function CDBeta     *)
(*           provides the corresponding cumulative Beta distribution     *)
(*           probability.                                                *)
(*                                                                       *)
```

```
    IF( X >= 1.0 ) THEN GOTO 9000;
                                        (* If X > A / ( A + B ) then swap *)
                                        (* A, B for more efficient eval.  *)

    IF( X > ( A / ( A + B ) ) ) THEN
      BEGIN
        X      := 1.0 - X;
        A      := Beta;
        B      := Alpha;
        QSwap  := TRUE;
      END;
                                        (* Check for extreme values *)

    IF( ( X = A ) OR ( X = B ) ) THEN GOTO 20;
    IF( A = ( ( B * X ) / ( 1.0 - X ) ) ) THEN GOTO 20;
    IF( ABS( A - ( X * ( A + B ) ) ) <= Epsz ) THEN GOTO 20;

       C     := ALGama( A + B ) + A * LN( X ) +
                B * LN( 1.0 - X ) - ALGama( A ) - ALGama( B ) -
                LN( A - X * ( A + B ) );

       IF( ( C < -36.0 ) AND QSwap ) THEN GOTO 9000;

          CDBeta := 0.0;
          IF(  C < -180.0 ) THEN GOTO 9000;

                                        (*  Set up continued fraction expansion *)
                                         (*  evaluation.                         *)

20:
      Apb    := A + B;
      Zm     := 0.0;
      Alo    := 0.0;
      Bod    := 1.0;
      Bev    := 1.0;
      Bhi    := 1.0;
      Blo    := 1.0;

      Ahi    := EXP( ALGama( Apb ) + A * LN( X ) +
                     B * LN( 1.0 - X ) - ALGama( A + 1.0 ) -
                     ALGama( B ) );

      F      := Ahi;

      Iter   := 0;

                                        (* Continued fraction loop begins here. *)
                                        (* Evaluation continues until maximum   *)
                                         (* iterations are exceeded, or          *)
                                         (* convergence achieved.                *)

      Qconv  := FALSE;

      REPEAT

         Fx     := F;

         Zm1    := Zm;
         Zm     := Zm + 1.0;
         D1     := A + Zm + Zm1;
         Aev    := -( A + Zm1 ) * ( Apb + Zm1 ) * X / D1 / ( D1 - 1.0 );
         Aod    := Zm * ( B - Zm ) * X / D1 / ( D1 + 1.0 );
         Alo    := Bev * Ahi + Aev * Alo;
         Blo    := Bev * Bhi + Aev * Blo;
         Ahi    := Bod * Alo + Aod * Ahi;
         Bhi    := Bod * Blo + Aod * Bhi;
```

```
(*          method works well unless the minimum of (Alpha, Beta)       *)
(*           exceeds about 70000.                                       *)
(*                                                                      *)
(*          An error in the input arguments results in a returned       *)
(*           probability of -1.                                         *)
(*                                                                      *)
(*----------------------------------------------------------------------*)

VAR
   Epsz : REAL;
   A    : REAL;
   B    : REAL;
   C    : REAL;
   F    : Double;
   Fx   : Double;
   Apb  : REAL;
   Zm   : REAL;
   Alo  : REAL;
   Ahi  : Double;
   Blo  : REAL;
   Bhi  : Double;
   Bod  : REAL;
   Bev  : REAL;
   Zm1  : REAL;
   D1   : REAL;
   Aev  : REAL;
   Aod  : REAL;

   Ntries : INTEGER;

   Qswap  : BOOLEAN;
   Qdoit  : BOOLEAN;
   Qconv  : BOOLEAN;

LABEL  20, 9000;

BEGIN (* CdBeta *)

                                   (* Initialize *)
   IF Dprec > MaxPrec THEN
      Dprec := MaxPrec
   ELSE IF Dprec <= 0 THEN
      Dprec := 1;

   Cprec  := Dprec;

   Epsz   := PowTen( -Dprec );

   X      := X;
   A      := Alpha;
   B      := Beta;
   QSwap  := FALSE;
   CDBeta := -1.0;
   Qdoit  := TRUE;
                                   (* Check arguments *)
                                   (* Error if:       *)
                                   (*    X <= 0       *)
                                   (*    A <= 0       *)
                                   (*    B <= 0       *)

   Ifault := 1;

   IF( X <= 0.0 ) THEN GOTO 9000;

   IF( ( A <= 0.0 ) OR ( B <= 0.0 ) ) THEN GOTO 9000;

   CDBeta := 1.0;
   Ifault := 0;
                                   (* If X >= 1, return 1.0 as prob *)
```

```
          Ihi    := Iof + 7;

          Top    := P[ Iof ];
          Bot    := Q[ Iof ];

          FOR I := Ilo TO Ihi DO
             BEGIN
                Top    := Top * Rarg + P[ I ];
                Bot    := Bot * Rarg + Q[ I ];
             END;

          Algval := Scale * ( Top / Bot ) + Alinc;

       END;

    IF( Qminus ) THEN Algval := Frac - Algval;

    ALGama := Algval;

END  (* ALGama *);


(*-------------------------------------------------------------------*)
(*            CDBeta -- Cumulative Beta Distribution                 *)
(*-------------------------------------------------------------------*)

FUNCTION CDBeta(     X,     Alpha, Beta: REAL;
                  Dprec, MaxIter    : INTEGER;
               VAR Cprec            : REAL;
               VAR Iter             : INTEGER;
               VAR Ifault           : INTEGER  ) : REAL;

(*-------------------------------------------------------------------*)
(*                                                                   *)
(*      Function:  CDBeta                                            *)
(*                                                                   *)
(*      Purpose:  Evaluates CPDF of Incomplete Beta Function         *)
(*                                                                   *)
(*      Calling Sequence:                                            *)
(*                                                                   *)
(*         P     := CDBeta(     X, Alpha, Beta: REAL;                *)
(*                            Dprec, Maxitr : INTEGER;               *)
(*                         VAR Cprec         : REAL;                 *)
(*                         VAR Iter          : INTEGER;              *)
(*                         VAR Ifault        : INTEGER  ) : REAL;    *)
(*                                                                   *)
(*              X      --- Upper percentage point of PDF             *)
(*              Alpha  --- First shape parameter                     *)
(*              Beta   --- Second shape parameter                    *)
(*              Dprec  --- Number of digits of precision required    *)
(*              Maxitr --- Maximum number of iterations              *)
(*              Cprec  --- Actual resulting precision                *)
(*              Iter   --- Iterations actually used                  *)
(*              Ifault --- error indicator                           *)
(*                         = 0:  no error                            *)
(*                         = 1:  argument error                      *)
(*                                                                   *)
(*              P      --- Resultant probability                     *)
(*                                                                   *)
(*      Calls:                                                       *)
(*                                                                   *)
(*         ALGama                                                    *)
(*                                                                   *)
(*      Method:                                                      *)
(*                                                                   *)
(*         The continued fraction expansion as given by              *)
(*         Abramowitz and Stegun (1964) is used.  This               *)
```

```
        Qdoit := FALSE
      ELSE
        BEGIN
          Frac   := Bot * PI / SIN( Top * PI );
          Rarg   := Rarg + 1.0;
          Frac   := LN( ABS( Frac ) );
        END;

  END;
                                  (* Choose approximation interval *)
                                  (* based upon argument range     *)

IF( Rarg = 0.0 ) THEN
  Qdoit := FALSE

ELSE IF( Rarg <= 0.5 ) THEN
  BEGIN

    Alinc  := -LN( Rarg );
    Scale  := Rarg;
    Rarg   := Rarg + 1.0;

    IF( Scale < Zeta ) THEN
      BEGIN
        Algval := Alinc;
        Qdoit  := FALSE;
      END;

  END

ELSE IF ( Rarg <= 1.5 ) THEN
  Scale := Rarg - 1.0

ELSE IF( Rarg <= 4.0 ) THEN
  BEGIN
    Scale  := Rarg - 2.0;
    Iof    := 9;
  END

ELSE IF( Rarg <= 12.0 ) THEN
  Iof := 17

ELSE IF( Rarg <= RMAX   ) THEN
  BEGIN

    Alinc  := ( Rarg - 0.5 ) * LN( Rarg ) - Rarg + Xln2sp;
    Scale  := 1.0 / Rarg;
    Rarg   := Scale * Scale;

    Top    := P[ 25 ];

    FOR I := 26 TO 29 DO
      Top    := Top * Rarg + P[ I ];

    Algval := Scale * Top + Alinc;

    Qdoit  := FALSE;

  END;
                                  (* Common evaluation code for Arg <= 12. *)
                                  (* Horner's method is used, which seems  *)
                                  (* to give better accuracy than          *)
                                  (* continued fractions.                  *)

IF Qdoit THEN
  BEGIN

    Ilo    := Iof + 1;
```

```
                    -8.73167543823839E+07 ,
                     1.11938535429986E+08 ,
                     4.81807710277363E+08 ,
                    -2.44832176903288E+08 ,
                    -2.40798698017337E+08 ,

                     8.06588089900001E-04 ,
                    -5.94997310888900E-04 ,
                     7.93650067542790E-04 ,
                    -2.77777777688189E-03 ,
                     8.33333333333330E-02   );

   Q           : ARRAY [ 1 .. 24 ] OF REAL =
                   ( 1.00000000000000E+00 ,
                     4.56467718758591E+01 ,
                     3.77837248482394E+02 ,
                     9.51323597679706E+02 ,
                     8.46075536202078E+02 ,
                     2.62308347026946E+02 ,
                     2.44351966250631E+01 ,
                     4.09779292109262E-01 ,

                     1.00000000000000E+00 ,
                     1.28909318901296E+02 ,
                     3.03990304143943E+03 ,
                     2.20295621441566E+04 ,
                     5.71202553960250E+04 ,
                     5.26228638384119E+04 ,
                     1.44020903717009E+04 ,
                     6.98327414057351E+02 ,

                     1.00000000000000E+00 ,
                    -2.01527519550048E+03 ,
                    -3.11406284734067E+05 ,
                    -1.04857758304994E+07 ,
                    -1.11925411626332E+08 ,
                    -4.04435928291436E+08 ,
                    -4.35370714804374E+08 ,
                    -7.90261111418763E+07   );

BEGIN (* ALGama *)

                                          (* Initialize *)

      Algval := Rinf;
      Scale  := 1.0;
      Alinc  := 0.0;
      Frac   := 0.0;
      Rarg   := Arg;
      Iof    := 1;
      Qminus := FALSE;
      Qdoit  := TRUE;
                                          (* Adjust for negative argument *)

      IF( Rarg < 0.0 ) THEN
         BEGIN

            Qminus := TRUE;
            Rarg   := -Rarg;
            Top    := Int( Rarg );
            Bot    := 1.0;

            IF( ( INT( Top / 2.0 ) * 2.0 ) = 0.0 ) THEN Bot := -1.0;

            Top    := Rarg - Top;

            IF( Top = 0.0 ) THEN
```

```
(*      Called By:  Many (CDBeta, etc.)                                    *)
(*                                                                         *)
(*      Remarks:                                                           *)
(*                                                                         *)
(*         Minimax polynomial approximations are used over the             *)
(*         intervals [-inf,0], [0,.5], [.5,1.5], [1.5,4.0],                *)
(*          [4.0,12.0], [12.0,+inf].                                       *)
(*                                                                         *)
(*         See Hart et al, "Computer Approximations",                      *)
(*          Wiley(1968), p. 130F, and also                                 *)
(*                                                                         *)
(*         Cody and Hillstrom, "Chebyshev approximations for               *)
(*         the natural logarithm of the Gamma function",                   *)
(*         Mathematics of Computation, 21, April, 1967, P. 198F.           *)
(*                                                                         *)
(*                                                                         *)
(*         There are some machine-dependent constants used --              *)
(*                                                                         *)
(*            Rmax   --- Largest value for which ALGama                    *)
(*                       can be safely computed.                           *)
(*            Rinf   --- Largest floating-point number.                    *)
(*            Zeta   --- Smallest floating-point number                    *)
(*                       such that (1 + Zeta) = 1.                         *)
(*                                                                         *)
(*-------------------------------------------------------------------------*)

VAR
   Rarg        : REAL;
   Alinc       : REAL;
   Scale       : REAL;
   Top         : REAL;
   Bot         : REAL;
   Frac        : REAL;
   Algval      : Double;

   I           : INTEGER;
   Iapprox     : INTEGER;
   Iof         : INTEGER;
   Ilo         : INTEGER;
   Ihi         : INTEGER;

   Qminus      : BOOLEAN;
   Qdoit       : BOOLEAN;

(* Structured *) CONST

   P           : ARRAY [ 1 .. 29 ] OF REAL =
                 ( 4.12084318584770E+00 ,
                   8.56898206283132E+01 ,
                   2.43175243524421E+02 ,
                  -2.61721858385614E+02 ,
                  -9.22261372880152E+02 ,
                  -5.17638349802321E+02 ,
                  -7.74106407133295E+01 ,
                  -2.20884399721618E+00 ,

                   5.15505761764082E+00 ,
                   3.77510679797217E+02 ,
                   5.26898325591498E+03 ,
                   1.95536055406304E+04 ,
                   1.20431738098716E+04 ,
                  -2.06482942053253E+04 ,
                  -1.50863022876672E+04 ,
                  -1.51383183411507E+03 ,

                  -1.03770165173298E+04 ,
                  -9.82710228142049E+05 ,
                  -1.97183011586092E+07 ,
```

```
(*       Powval := PowTen( Power: INTEGER ) : REAL;                        *)
(*                                                                         *)
(*          Power  --- power of ten desired (must be integer)              *)
(*                                                                         *)
(*          Powval --- resultant power of ten value                        *)
(*                                                                         *)
(*     Calls:  None                                                        *)
(*                                                                         *)
(*-------------------------------------------------------------------------*)

VAR
   Temp   : REAL;
   I      : INTEGER;
   AbsPow : INTEGER;
   X      : REAL;

BEGIN (* PowTen *)

   X      := 10.0;

   IF Power < 0 THEN
      BEGIN
         Power := -Power;
         X     := 0.1;
      END;

   Temp := 1.0;

   WHILE( Power > 0 ) DO
      BEGIN

         WHILE ( NOT ODD( Power ) ) DO
            BEGIN
               Power := Power DIV 2;
               X     := X * X;
            END;

         Power := Power - 1;
         Temp  := Temp  * X;

      END;

   PowTen := Temp;

END  (* PowTen *);


(*-------------------------------------------------------------------------*)
(*               ALGama  -- Logarithm of Gamma Distribution                *)
(*-------------------------------------------------------------------------*)

FUNCTION ALGama( Arg : REAL ) : REAL;

(*-------------------------------------------------------------------------*)
(*                                                                         *)
(*      Function:  ALGama                                                  *)
(*                                                                         *)
(*      Purpose:  Calculates Log (base E) of Gamma function                *)
(*                                                                         *)
(*      Calling Sequence:                                                  *)
(*                                                                         *)
(*           Val := ALGama( Arg )                                          *)
(*                                                                         *)
(*                Arg   --- Gamma distribution parameter (Input)           *)
(*                Val   --- output Log Gamma value                         *)
(*                                                                         *)
(*      Calls:  None                                                       *)
(*                                                                         *)
```

```
(*              Global constants for significance routines                *)
(*------------------------------------------------------------------------*)
(*              WARNING:  These are for Turbo-87 only!!!!!                *)
(*------------------------------------------------------------------------*)

CONST
   PI        = 3.141592653589793      (* Math constant PI        *);
   Xln2sp    = 9.18938533204673E-01   (* LogE( Sqrt( 2 * PI ) ) *);
   Rmax      = 1.67E+308              (* Maximum flt pt number   *);
   Rsmall    = 4.19E-306              (* Smallest flt pt number *);
   Rinf      = 1.67E+308              (* Machine "infinity"      *);
   Zeta      = 1.0E-16                (* Approx. machine prec.   *);
   MaxPrec   = 16                     (* Max. precision          *);
   Sqrt2     = 1.4142135623730950     (* Square root of 2        *);
   LnTenInv  = 0.4342944819032520     (* 1 / LN(10)              *);
   LnTwo     = 0.6931471805599450     (* LN(2)                   *);


(*------------------------------------------------------------------------*)
(*                LogTen --- Calculate base 10 logarithm                  *)
(*------------------------------------------------------------------------*)

FUNCTION LogTen( X: REAL ) : REAL;

(*------------------------------------------------------------------------*)
(*                                                                        *)
(*     Function:  LogTen                                                  *)
(*                                                                        *)
(*     Purpose:  Calculates base ten logarithm                            *)
(*                                                                        *)
(*     Calling Sequence:                                                  *)
(*                                                                        *)
(*        Logval := LogTen( X: REAL ) : REAL;                             *)
(*                                                                        *)
(*           X      --- value to find logarithm of                        *)
(*                                                                        *)
(*           Logval --- resultant logarithm (X > 0);                      *)
(*                      = 0 if X <= 0.                                    *)
(*                                                                        *)
(*     Calls:  LN                                                         *)
(*                                                                        *)
(*------------------------------------------------------------------------*)

BEGIN (* LogTen *)

   IF X <= 0.0 THEN
      LogTen := 0.0
   ELSE
      LogTen := LN( X ) * LNTenInv;

END   (* LogTen *);


(*------------------------------------------------------------------------*)
(*                 PowTen --- Calculate power of ten                      *)
(*------------------------------------------------------------------------*)

FUNCTION PowTen( Power : INTEGER ) : REAL;

(*------------------------------------------------------------------------*)
(*                                                                        *)
(*     Function:  PowTen                                                  *)
(*                                                                        *)
(*     Purpose:  Calculates power of ten (integer powers only)            *)
(*                                                                        *)
(*     Calling Sequence:                                                  *)
(*                                                                        *)
```

```
    writeln('PATTERN    = ',P);
    writeln;
    writeln('NLA        = ',NLA);
    writeln;
    writeln('NLB        = ',NLB);
    writeln;
    writeln('SUBJECTS   = ',N);
    writeln;writeln;
    writeln('for ',NRep,' Replications');
    writeln;
    writeln('of ',NRunsMax,' Runs each');
    writeln;
    writeln('Starting with Run No. ',(RunStartNo-1)*1000+1);
    writeln;writeln;
    write('Is this OK? (Y or N)?: ');
    read(ANS);
  until ((ANS = 'Y') or (ANS = 'y'));
end; {procedure initialize}
{..............................................................

{..............................................................}
begin {main}
  Initialize;
  RandSeed := meml[$0040:$006C];
  for r := 0 to NRep-1 do
     begin
        GetFiles;
        ClrScr;
        GoToXY(28,6);
        write('RandSeed = ', randseed);
        delay(2000);
        writeln(SaveFile,Randseed);
        NRuns := (RunStartNo-1)*1000;
        for l := 1 to NRunsMax do
           begin
             Clrscr;
             GoToXY(28,8);
             Write('REPLICATION NUMBER = ',r+1:2);
             NRuns := NRuns +1;
             GoToXY(30,10);
             Write('RUN NUMBER = ',NRuns:5);
             GoToXY(35,14);
             Write('GenRan   ');
             GenRan;
             GoToXY(35,14);
             write('GetMeans');
             GetMeans;
             GoToXY(35,14);
             write('Anova    ');
             Anova;
             GoToXY(35,14);
             write('SimpEff ');
             SimpEff;
             GoToXY(35,14);
             write('SimpComp');
             SimpComp;
             GoToXY(35,14);
             Write('SaveData');
             SaveData;
           end; {for l}
     end; {for r}
  {Close(SaveFile); }
end.
{..............................................................}


(*------------------------------------------------------------*)
```

```
repeat
   clrscr;
   writeln('What is the condition number: ');
   writeln;
   writeln('          ES(A)    ES(AB)');
   writeln('    0 =  None     None    {Type I error}');
   writeln('    1 =  None     Medium');
   writeln('    2 =  None     Large');
   writeln('    3 =  None     Very Large');
   writeln('    4 =  Small    Medium');
   writeln('    5 =  Small    Large');
   writeln('    6 =  Small    Very Large');
   writeln('    7 =  Medium   Medium');
   writeln('    8 =  Medium   Large');
   writeln('    9 =  Medium   Very Large');
   GotoXY(31,1);
   read(ConditNo);
   str(ConditNo:1,SCN);
   clrscr;
   {Write('How many levels of Variable A (3, 4): ');
   readln(NLA);}
   NLA := 3;
   str(NLA:1,SNLA);
   {write('How many levels of Variable B (2, 3, 4, 5): ');
   readln(NLB);}
   NLB := 5;
   str(NLB:1,SNLB);
   clrscr;
   repeat
     writeln('What is the pattern number: ');
     writeln;
     writeln('   Pattern');
     writeln('     0 =  Use when Type I error');
     writeln('     1 =  Minimum Variability (All at middle except');
     writeln('                               one at each extreme)');
     writeln('     2 =  Medium Variability  (Equally spaced)');
     writeln('     3 =  Maximum Variability (All at two extremes)');
     writeln;
     writeln('NOTE: When Number levels of A = 3, Choose Pattern 1 or 3');
     writeln('           Pattern 2 = Pattern 1 in this case');
     GoToXY(31,1);
     read(P);
     str(P:1,SP);
     clrscr;
     if ((NLA = 3) and (P = 2)) then
       STOP := false
     else STOP := true;
   until (STOP);
   write('How many subjects per Group(8 or 15): ');
   readln(N);
   if (N = 8) then
     SN := 'S'
   else SN := 'L';
   clrscr;
   {write('How many runs do you wish to make? ');}
   NRunsMax := 1000;
   {readln(NRunsMax);writeln;
   write('How many Replications (1 ==> 10)? ');}
   NRep := 10;
   {readln(NRep);writeln;
   write('Starting with Replication Number (1 ==> 10)? ');}
   RunStartNo := 1;
   {readln(RunStartNo);}
   clrscr;
   writeln('The current run will be conducted under the following
conditions:');
   writeln;
   writeln('CONDITION  = ',ConditNo);
   writeln;
```

```
            NScores := 0;
            for i := 1 to NLB do
              for j := 1 to NLA do
                for k := 1 to N do
                 begin
                  NScores := NScores +1;
                  X[NScores] := RndNorm;
                 X[NScores] := X[NScores]+ ESa[2,j] + ESab[NLB+i,j];
                 end; {for k}
           end; {8}
       9:  begin
            NScores := 0;
            for i := 1 to NLB do
              for j := 1 to NLA do
                for k := 1 to N do
                 begin
                  NScores := NScores +1;
                  X[NScores] := RndNorm;
                 X[NScores] := X[NScores]+ ESa[2,j] + ESab[2*NLB+i,j];
                 end; {for k}
           end; {9}
  end; {case}
end; {Genran}
{...............................................................}

{...............................................................}
procedure getfiles;

begin
  if (conditno <> 0) then
     begin
      ESaFilename := concat('c:\greg\ESa',SNLA,'P',SP,'.DAT');
       writeln(ESaFilename);
                                                       {ESa }
        Assign(EffSizeA, ESaFilename);        {       A1  A2  A3  A4}
        reset(EffSizeA);                      {Small                }
        for i := 1 to 2 do                    {Medium               }
          begin
            for j := 1 to NLA do
             read(EffSizeA, ESa[i,j]);
           readln(EffSizeA);
          end;
        close(EffSizeA);
      ESabFilename := concat('c:\greg\ESab',SNLA,SNLB,'P',SP,'.DAT');
        writeln(ESabFilename);                          {ESab}
                                               {       A1  A2  A3  A4 }
        Assign(EffSizeAB, ESabFilename);       {Sm-B1                }
        reset(EffSizeAB);                      {Sm-B2                }
        for k := 1 to 3 do                     {Md-B1                }
          for i := 1 to NLB do                 {Md-b2                }
            begin                              {....                 }
              for j := 1 to NLA do             {Lg-B2                }
              read(EffSizeAB, ESab[(NLB*(k-1)+i),j]);
           readln(EffSizeAB);
            end; {for i}
        close(EffSizeAB);
  end; {if ConditNo}
  str(r:1,RSN);
  SaveFilename :=
concat('c:\greg\data\C',SCN,'P',SP,'D',SNLA,SNLB,SN,'.R',RSN);
  Assign (SaveFile, SaveFilename);
  Rewrite(SaveFile)
end; {procedure get files}
{...............................................................}

{...............................................................}
procedure initialize;

begin
```

```
          end; {for k}
     end; {1}
2:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ESab[NLB+i,j];
          end; {for k}
     end; {2}
3:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ESab[2*NLB+i,j];
          end; {for k}
     end; {3}
4:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ ESa[1,j] + ESab[i,j];
          end; {for k}
     end; {4}
5:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ ESa[1,j] + ESab[NLB+i,j];
          end; {for k}
     end; {5}
6:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ ESa[1,j] + ESab[2*NLB+i,j];
          end; {for k}
     end; {6}
 7:  begin
      NScores := 0;
      for i := 1 to NLB do
        for j := 1 to NLA do
          for k := 1 to N do
           begin
            NScores := NScores +1;
            X[NScores] := RndNorm;
           X[NScores] := X[NScores]+ ESa[2,j] + ESab[i,j];
          end; {for k}
     end; {7}
 8:  begin
```

```
  for i := 1 to NLB do
    begin
      for j := 1 to NLA do
       Means[i,ColMax] := Means[i,ColMax] + Means[i,j];
     means[i,ColMax] := means[i,ColMax]/NLA;
    end; {for j}
end;  {Get Means}
{...................................................................}

{******************************************************************}
function Randum:real;

const
   a = 16807;
   m = 2147483647;
   q = 127773; (* m div a *)
   r = 2836; (* m mod a *)

var
  lo, hi, test :longint;

begin
   Hi := RandSeed div q;
   lo := RandSeed mod q;
   test := a * lo - r * hi;
   if test > 0 then
      RandSeed := test
   else
      RandSeed := test + m;
   Randum := RandSeed/m;
end; {function randum}
{*******************************************************************}

{...................................................................}
function RndNorm:real;

var
  RandomA, RandomB, Radius2 : real;

begin
  repeat
    RandomA := 2.0 * randum - 1.0;
    RandomB := 2.0 * randum - 1.0;
   Radius2 := sqr(RandomA) + sqr(RandomB)
  until
    Radius2 < 1.0;
 RndNorm := RandomA * sqrt((-2.0*ln(Radius2))/Radius2);
end; {RndNorm}
{...................................................................}

{...................................................................}
procedure GenRan;

begin
  case ConditNo of
    0:  begin
          NScores := NLA * NLB * N;
          for i := 1 to NScores do
            X[i] := RndNorm;
        end;
    1:  begin
          NScores := 0;
          for i := 1 to NLB do
            for j := 1 to NLA do
              for k := 1 to N do
               begin
                 NScores := NScores +1;
                 X[NScores] := RndNorm;
                X[NScores] := X[NScores]+ESab[i,j];
```

```
  SSb := SSb * N * NLA;

  {FInd SSab}
  SSab := SSbg - SSa - SSb;

  {Find Dfs}
  DFa := NLA -1;
  DFb := NLB -1;
  DFab := DFa * DFb;
  DFwg := NLA * NLB * (N-1);

  {Find MS}
  MSa := SSa/DFa;
  MSb := SSb/Dfb;
  MSab := SSab/DFab;
  MSwg := SSwg/DFwg;

  {Find Fs}
  Fa := MSa/MSwg;
  Fb := MSb/MSwg;
  Fab := MSab/MSwg;

  {Find Fprob}
  FProbA := sigF(Fa,DFa,DFwg);
  FProbB := sigF(Fb,DFb,DFwg);
  FProbAB := sigF(Fab,DFab,DFwg);
end; {Anova}
{.........................................................................}

{.........................................................................}
procedure GetMeans;

begin
  {Initialize means matrix}                   {       A1  A2  A3  A4  Bmeans}
  for i := 1 to RowMax do                     {B1                          }
    for j := 1 to ColMax do                   {B2                          }
      Means[i,j] := 0.0;                      {..                          }
                                              {Ameans                 Gmean }
  {Find Condition Means}
  NC := 0;
  for i := 1 to NLB do
    begin
      for j := 1 to NLA do
        begin
          NC := NC +1;
          S := N * (NC-1) +1;
          E := S+N-1;
          for k := S to E do
            begin
             Means[i,j] := Means[i,j] + X[k];
            Means[RowMax,ColMax] := Means[RowMax,ColMax] + X[k];
            end;
         means[i,j] := means[i,j]/N;
        end; {for j}
    end; {for i}

  {Find Grand Mean}
 Means[RowMax,ColMax] := Means[RowMax,ColMax]/(N*NLA*NLB);

  {Find A means}
  for j := 1 to NLA do
    begin
      for i := 1 to NLB do
       Means[RowMax,j] := Means[RowMax,j] + Means[i,j];
     means[RowMax,j] := means[RowMax,j]/NLB;
    end; {for j}

  {Find B means}
```

```
     for j := 1 to (NLA-1) do
       for k := (j+1) to NLA do
           begin
             NSC := NSC + 1;
            SC[NSC,1] := (N/2* (Means[i,j]- Means[i,k]) *
                                  (Means[i,j] - Means[i,k]));
            SC[NSC,2] := SC[NSC,1]/MSwg;
            SC[NSC,3] := sigF(SC[NSC,2], 1, DFwg);
           end; {for k}
end; {SimpComp}
{...........................................................................}

{...........................................................................}
procedure SimpEff;

begin                                                {     SS   MS   F   FProb}
   {initialize SE}                                   {SE1                     }
   for i := 1 to NLB do                              {SE2                     }
       for j := 1 to 4 do                            {                        }
         SE[i,j] := 0;
   {obtain simple effects}
   for i := 1 to NLB do
       begin
            for j := 1 to NLA do
               SE[i,1] := SE[i,1] + (Means[i,j] - Means[i,ColMax]) *
                                    (Means[i,j] - Means[i,ColMax]);
           SE[i,1] := SE[i,1] * N;
           SE[i,2] := SE[i,1]/(NLA-1);
           SE[i,3] := SE[i,2]/MSwg;
           SE[i,4] := sigF(SE[i,3], DFa, DFwg);
       end; {for i}
end; {SimpEff}
{...........................................................................}

{...........................................................................}
procedure Anova;

begin
  {Initialize SS}
  SStot := 0;
  SSbg := 0;
  SSa  := 0;
  SSb  := 0;

  {Find SSTot}
  For k := 1 to (N*NLA*NLB) do
     SStot := SSTot + (X[k] - Means[RowMax,ColMax]) *
                      (X[k] - Means[RowMax,ColMax]);

  {Find SSbg}
  for i := 1 to NLB do
      for j := 1 to NLA do
           SSbg := SSbg + (Means[i,j] - Means[RowMax,ColMax]) *
                          (Means[i,j] - Means[RowMax,ColMax]);
  SSbg := SSbg * N;

  {Find SSwg}
  SSwg := SSTot - SSbg;

  {Find SSa}
  for j := 1 to NLA do
    SSa := SSa + (Means[Rowmax,j] - Means[RowMax,Colmax]) *
                 (Means[RowMax,j] - Means[RowMax,ColMax]);
  SSa := SSa * N * NLB;

  {Find SSb}
  for i := 1 to NLB do
    SSb := SSb + (Means[i,ColMax] - Means[RowMax,Colmax]) *
                 (Means[i,ColMax] - Means[RowMax,ColMax]);
```

```
var
  bt: real;

begin
  if ((x < 0.0) or (x > 1.0)) then
    begin
     writeln('pause in routine betai');
      readln;
    end;
  if ((x = 0.0) or (x = 1.0)) then
     bt := 0.0
  else
   bt := exp(gammln(a+b) - gammln(a) -gammln(b)
        + a * ln(x) + b * ln(1.0 - x));
  if (x < ((a + 1.0)/(a + b + 2.0))) then
   betai := bt * betacf(a, b, x)/a
  else
   betai := 1.0 - bt * betacf(b, a, 1.0-x)/b;
end; {function betai}
{.................................................................}

{.................................................................}
function sigf(F: real; df1, df2: integer): real;

begin
      sigf :=   betai(0.5 * df2, 0.5 * df1, df2/(df2 + df1 * F));
      {prob2 :=  + (1.0 -betai(0.5 * df1, 0.5 * df2, df1/(df1 + df2/F)));}
end; {sigf}
{.................................................................}

{.................................................................}
procedure SaveData;

var
   NPW  : integer;

begin
  Append(SaveFile);
  NPW := (NLA * (NLA-1)) div 2;
  writeln(Savefile,
ConditNo:1,N:3,NLA:2,NLB:1,P:2,NRuns:6,MSwg:10:3,FprobA:9:5,
                         FprobB:9:5,FprobAB:9:5);
  write(SaveFile, ConditNo:1,N:3,NLA:2,NLB:1,P:2,NRuns:6);
   for i := 1 to NLB do
    write(SaveFile, SE[i,4]:9:5);
  writeln(SaveFile);
   for i := 1 to NLB do
     begin
      write(SaveFile, ConditNo:1,N:3,NLA:2,NLB:1,P:2,NRuns:6);
       for j := 1 to NPW do
        write(SaveFile,SC[(NPW * (i-1)+j),3]:9:5);
       writeln(SaveFile);
     end; {for i}
  Close(Savefile);
end; {procedure SAveData}
{.................................................................}


{.................................................................}
procedure SimpComp;

begin
   {Initialize}
    for i := 1 to SCMax do               {    SS/MS  F  FProb}
      for j := 1 to 3 do                 {SC1                }
        SC[i,j] := 0;                    {SC2                }
    {Simple Comparisons}                  {SC3                }
    NSC := 0;
    for i := 1 to NLB do
```

```
  am := 1.0;
  bm := 1.0;
  az := 1.0;
  qab := a + b;
  qap := a + 1.0;
  qam := a - 1.0;
  bz := 1.0 - qab * x/qap;
  for m := 1 to itmax do
    begin
      em := m;
      tem := em + em;
      d := em * (b-m) * x/((qam + tem) * (a + tem));
      ap := az + d * am;
      bp := bz + d * bm;
      d := -(a + em) * (qab + em) * x/((a + tem) * (qap + tem));
      app := ap + d * az;
      bpp := bp + d * bz;
      aold := az;
      am := ap/bpp;
      bm := bp/bpp;
      az := app/bpp;
      bz := 1.0;
      if ((abs(az - aold)) < (eps * abs(az))) then
        goto 1;
    end;
   writeln('pause in BETACF');
   writeln('a or b too big, or itmax too small');
   readln;
1:  betacf := az;
end; {function betacf}
{...............................................................}

{...............................................................}
function gammln (xx: real): real;

const
   stp = 2.50662827465;
   half = 0.5;
   one = 1.0;
   fpf = 5.5;

var
   x,tmp,ser          : double;
   j                  : integer;
   cof                : array [1..6] of double;

begin
  cof[1] :=  76.18009173;
  cof[2] := -86.50532033;
  cof[3] :=  24.01409822;
  cof[4] :=  -1.231739516;
  cof[5] :=   0.120858003e-2;
  cof[6] :=  -0.536382e-5;
  x:= xx-one;
  tmp := x + fpf;
  tmp := (x+half)*ln(tmp)-tmp;
  ser := one;
  for j := 1 to 6 do
    begin
      x := x + one;
      ser := ser + cof[j]/x;
    end;
  gammln := (tmp+ln(stp * ser));
end; {function gammln}
{...............................................................}

{...............................................................}
function betai(a,b,x: real): real;
```

```
program generation;

{$N+,E-}

uses
  CRT;

const

   NMax = 240;    {Max no scores: 4x4x15}
   RowMax = 6;
   ColMax = 5;
   SCMax = 30;    {Max simp comp}

var
   ConditNo                     : integer; {Condition Number}
   NLA                          : integer; {Number levels of A: 3-4}
   NLB                          : integer; {Number levels of B: 2-5}
   N                            : integer; {Number of subjects per condit: 8 or
15}
   P                            : integer; {Pattern No.}
   NScores                      : integer; {Number of scores to be generated}
  NRuns,NRunsMax,RunStartNo      : integer;
   i,j,k,l,S,E,NC,NSC            : Integer;
                                   {S = start}
                                   {E = end}
                                  {NC = No Condit}
                                  {NSC = No Simp Comp}
   X                            : array [1..NMax] of real;
   Means                        : array[1..RowMax,1..ColMax] of real;
  SSTot,SSbg,SSwg,SSa,SSb,SSab : real;
   DFa,DFb,DFab,DFwg             : integer;
   MSa,MSb,MSab,MSwg             : real;
   Fa,Fb,Fab                     : real;
   FProbA,FProbB,FProbAB         : real;
   SE                           : array[1..5,1..4] of Real;
   SC                           : array[1..SCMax,1..3] of Real;
  Savefile, EffSizeA,EffSizeAB : Text;
   ESa                          : array[1..2,1..4] of real;
   ESab                         : array[1..15,1..4] of real;
   SCN,SNLA,SNLB,RSN,SP,SN        : string[5];
   SaveFileName                  : string[35];
   ESaFilename                   : string[35];
   ESabFilename                  : string[35];
   ANS                           : char;
   STOP                          : boolean;
   RandSeed                      : longint;
   r,NRep                        : integer;


{.................................................................}
function betacf(a,b,x: real): real;

label 1;

const
  itmax = 100;
  eps = 3.0e-7;

var
  tem,qap,qam,qab,em,d   : real;
  bz,bpp,bp,bm,az,app    : real;
  am, aold,ap            : real;
  m                      : integer;

begin
```

APPENDIX A

DATA GENERATION PROGRAMS

psychological sciences have been found to be relatively low (see, for example, Sedlmeier & Gigerenzer, 1989), researchers should select a technique which provides the best possible chance to detect these effects.

The topic of Type I and Type II error control in the analysis of interaction effects is a potentially fruitful area of research. A number of additional studies of post-hoc multiple comparison techniques in factorial designs could be conducted. The most imperative of the future studies should examine what happens when the assumptions underlying the analysis of variance are violated. Again, research (Keppel, 1982; Zwick & Marascuillo, 1984) has shown that the Fisher technique is greatly affected when unequal sample sizes are coupled with unequal variances. Given that the logic behind the Keppel technique is similar to that of the Fisher technique, it, too may be greatly affected in these situations. Prior to the conduct of these studies, researchers are strongly urged to test for violations of the assumptions of analysis of variance if the Keppel technique is utilized to control familywise Type I error.

Further studies could examine more complex designs (i.e., three way designs). By adding an additional independent variable, an additional level of analysis is conducted. How would this affect these techniques in Type I error as well as Type II error and power?

In conclusion, the Keppel technique provides the best balance between Type I error control and power in the analysis of interactions. While the Fisher technique provides greater power than the Keppel technique, it does not control the compounding of familywise Type I error. In other words, the additional filter, the analysis of simple effects, adequately controls familywise Type I error. Additionally, techniques which penalize researchers for conducting multiple comparisons by adjusting α produce a marked decline in power in many cases, and are, therefore, not recommended. Because the typical effect sizes in the

The Fisher technique is questionable at this point because in Study 1 it did not control the compounding of familywise Type I error with n = 8. The empirical value of α_{FW} for Fisher when n = 8 was .0505. However, the empirical Type I error rate at the omnibus level when n = 8 was .0506. Therefore, the fact that α_{FW} exceeded .05 with the Fisher technique in Study 1 could be due to the fact that the generator produced data which yielded Type I error rates which were slightly high to begin with. In addition, as Keppel (1982) and Zwick and Marascuillo (1984) point out, the Fisher technique is affected greatly by the combination of unequal sample size and unequal variance. Further study of the use of this technique is necessary. If additional studies show that the Fisher technique is able to control the compounding of familywise error, it would be the method of choice when equal sample sizes and equal variances are present. In many of the cases presented in Study 2, the Fisher technique provided higher power than the other techniques (in some cases, the power of the Fisher technique was nearly as high as that of planned comparisons).

If researchers insist upon paying a penalty, the Tukey - Overall technique is clearly a poor choice due to its lack of power. In addition, the Bonferroni technique has lower power than the Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques in many situations, and, consequently, is not recommended either. The researcher must bear in mind that any adjustment to α (i.e., penalty paid for conducting post hoc multiple comparisons) results in a loss of power. While the techniques which require a penalty maintain a low probability of familywise Type I error, they incur an unnecessary loss in power to detect true effects.

CHAPTER IV

GENERAL DISCUSSION

First, it should be noted that the findings presented in this paper hold for post hoc multiple comparison procedures in 3 x 5 factorial experiments or smaller two-way designs. Consistent with the results of Riesing (1993), the studies presented in this paper show that, with the exception of the Fisher technique when n = 8, all of the techniques under investigation maintain control over the compounding of familywise Type I error (i.e., maintain $\alpha_{FW} < .05$). Therefore, when recommending a post-hoc multiple comparison technique for analyzing an interaction, the key issue is the statistical power to detect treatment effects.

The present studies support the use of the Keppel technique as a method of controlling the compounding of familywise Type I error. This technique maintains an acceptable familywise Type I error rate ($\alpha_{FW} = .046$) while it provides higher power than other techniques (second only to the Fisher technique; the Keppel technique and the Fisher technique differed by more than .05 in terms of Type II error in only 25% of the cases). Furthermore, the Keppel technique held Type I error to roughly .05 or less within the context of true treatment effects in all but one case (as discussed in Chapter III, this case is probably due to the generation of data which produced a higher-than-chance rate of Type I errors).

Table 8. (continued).

N	ESAB	ESSE	METHOD	TYPE I ERROR	N	ESAB	ESSE	METHOD	TYPE I ERROR	N	ESAB	ESSE	METHOD	TYPE I ERROR
15	0.25	.25000	PLAN	.0501	15	.40	.40000	PLAN	.0499	15	.60	.60000	PLAN	.0507
			FISH	.0420				FISH	.0499				FISH	.0507
			KEP	.0347				KEP	.0475				KEP	.0507
			MB	.0258				MB	.0428				MB	.0501
			MBB	.0251				MBB	.0424				MBB	.0501
			BON	.0195				BON	.0378				BON	.0495
			TRow	.0166				TRow	.0189				TRow	.0194
			TOvl	.0008				TOvl	.0008				TOvl	.0007
		.35000	PLAN	.0531			.50000	PLAN	.0490			.70000	PLAN	.0479
			FISH	.0478				FISH	.0490				FISH	.0479
			KEP	.0448				KEP	.0483				KEP	.0479
			MB	.0380				MB	.0467				MB	.0477
			MBB	.0379				MBB	.0465				MBB	.0477
			BON	.0334				BON	.0448				BON	.0476
			TRow	.0188				TRow	.0189				TRow	.0191
			TOvl	.0004				TOvl	.0010				TOvl	.0007
		.43302	PLAN	.0514			.65000	PLAN	.0528			.85001	PLAN	.0463
			FISH	.0446				FISH	.0528				FISH	.0463
			KEP	.0437				KEP	.0528				KEP	.0463
			MB	.0405				MB	.0526				MB	.0463
			MBB	.0405				MBB	.0526				MBB	.0463
			BON	.0383				BON	.0523				BON	.0463
			TRow	.0146				TRow	.0199				TRow	.0183
			TOvl	.0001				TOvl	.0007				TOvl	.0003
		.50000	PLAN	.0453										
			FISH	.0405										
			KEP	.0400										
			MB	.0386										
			MBB	.0386										
			BON	.0374										
			TRow	.0157										
			TOvl	.0004										

Table 8. Type I error rates within the context of true treatment effects.

N	ESAB	ESSE	METHOD	TYPE I ERROR
8	0.25	.25000	PLAN	.0504
			FISH	.0323
			KEP	.0240
			MB	.0162
			MBB	.0158
			BON	.0117
			TRow	.0132
			TOvl	.0006
		.35000	PLAN	.0484
			FISH	.0321
			KEP	.0287
			MB	.0222
			MBB	.0215
			BON	.0177
			TRow	.0128
			TOvl	.0004
		.43302	PLAN	.0480
			FISH	.0308
			KEP	.0279
			MB	.0237
			MBB	.0234
			BON	.0202
			TRow	.0112
			TOvl	.0010
		.50000	PLAN	.0483
			FISH	.0317
			KEP	.0296
			MB	.0274
			MBB	.0270
			BON	.0240
			TRow	.0128
			TOvl	.0011

N	ESAB	ESSE	METHOD	TYPE I ERROR
8	.40	.40000	PLAN	.0500
			FISH	.0480
			KEP	.0420
			MB	.0327
			MBB	.0319
			BON	.0259
			TRow	.0188
			TOvl	.0008
		.50000	PLAN	.0495
			FISH	.0463
			KEP	.0436
			MB	.0383
			MBB	.0380
			BON	.0327
			TRow	.0185
			TOvl	.0010
		.65000	PLAN	.0467
			FISH	.0442
			KEP	.0433
			MB	.0409
			MBB	.0409
			BON	.0391
			TRow	.0151
			TOvl	.0008

N	ESAB	ESSE	METHOD	TYPE I ERROR
8	.60	.60000	PLAN	.0505
			FISH	.0505
			KEP	.0490
			MB	.0455
			MBB	.0451
			BON	.0412
			TRow	.0190
			TOvl	.0008
		.70000	PLAN	.0513
			FISH	.0513
			KEP	.0504
			MB	.0488
			MBB	.0488
			BON	.0470
			TRow	.0210
			TOvl	.0008
		.85001	PLAN	.0491
			FISH	.0491
			KEP	.0491
			MB	.0487
			MBB	.0485
			BON	.0482
			TRow	.0187
			TOvl	.0005

assume that this explanation is valid. When the effect size of the interaction is very large, the probability of Type I error decreases as the effect size of the simple effect increases.

Finally, the techniques follow an order in terms of Type I error which is consistent with the results of Study 1: uncorrected pairwise comparisons has the greatest Type I error rate, followed by the Fisher technique, the Keppel technique, the Modified Bonferroni technique, the Modified Bonferroni - Both technique, the Bonferroni technique, the Tukey - Row technique, and the Tukey - Overall technique. Similar to the results of Reising (1993), the Type I error rates observed at the level of simple comparisons in Study 2, however, are greater than those in Study 1. The reason for this is that the ability of the omnibus analysis and the analysis of simple effects to prevent Type I errors at the level of simple comparisons is reduced when true treatment effects exist.

Type I Error in the Context of True Treatment Effects

In some cases in Study 2, the effect size of the simple comparison was .00000. The cases where the effect size of the simple comparison was null which were found significant represent Type I error within the context of true treatment effects. These cases were counted and converted to a probability. Table 8 presents these data for each method by sample size, the effect size of the interaction, and the effect size of the simple effect.

Generally, Type I error is slightly lower for the small sample size than for the large sample size. In addition, Type I error is slightly higher for larger effect sizes of the interaction. Type I error also varies as a function of the effect size of the simple effect. As the effect size of the simple effect increases, however, the probability of Type I error depends upon the effect size of the interaction. When effect size of the interaction is moderate or large, the probability of Type I error increases as the effect size of the simple effect increases. In fact, the probability of Type I error exceeds .05 for all of the techniques except Tukey - Row and Tukey - Overall when the effect size of the interaction is large, the effect size of the simple effect is .65000 and n = 15. However, an explanation for this anomalous result is that the randomly generated data simply produced more significant results by chance in these cases. Support for this explanation can be found by examining the Type I error rate for planned comparisons. With this technique, only simple comparisons with α_{PC} = .05 are conducted. Consequently, the Type I error rate for this technique should be approximately .05. In the case in question, the Type I error rate for the planned comparison technique is higher than .05 (.0528, to be exact). Therefore, it is reasonable to

More specifically, the following trends can be identified upon examining Figures 10A to 10F and Appendix E:

- when the effect size of the interaction is moderate and n = 8, the probability of Type II error for Tukey - Row does not differ by more than .05 from either Modified Bonferroni or Modified Bonferroni - Both; the probability of Type II error for Bonferroni is more than .05 larger than that of Tukey - Row when the effect size of the simple effect is .31225 or greater and when the effect size of the simple comparison is greater than the effect size of the simple effect.
- in the remainder of the combinations of sample size and interaction effect size, when the effect size of the simple comparison is greater than the effect size of the simple effect, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both have Type II error probabilities which are more than .05 greater than that of Tukey - Row (in 35%, 15%, and 17% of the cases, respectively). When the effect size of the simple effect is greater than the effect size of the simple comparison, the probability of Type II error with Tukey - Row is more than .05 higher than those of Modified Bonferroni and Modified Bonferroni - Both (in 23% of the total cases). Furthermore, the probability of Type II error with Tukey - Row is more than .05 higher than that Bonferroni when the effect size of the simple effect is greater than the effect size of the simple comparison and is .60000 or greater (16% of the total cases).

Figure 10E. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .60.

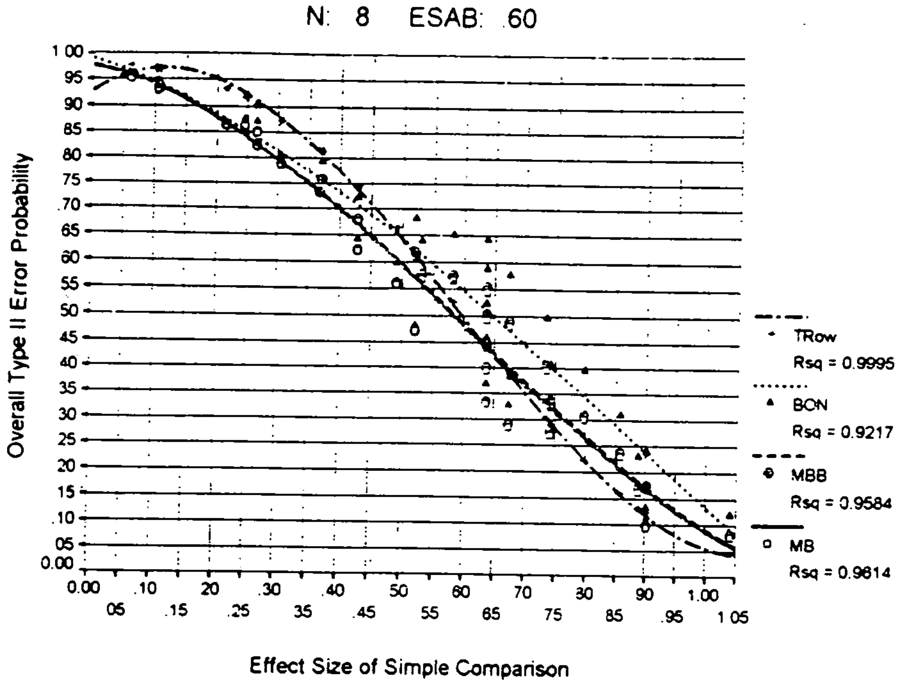


Figure 10F. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .60.

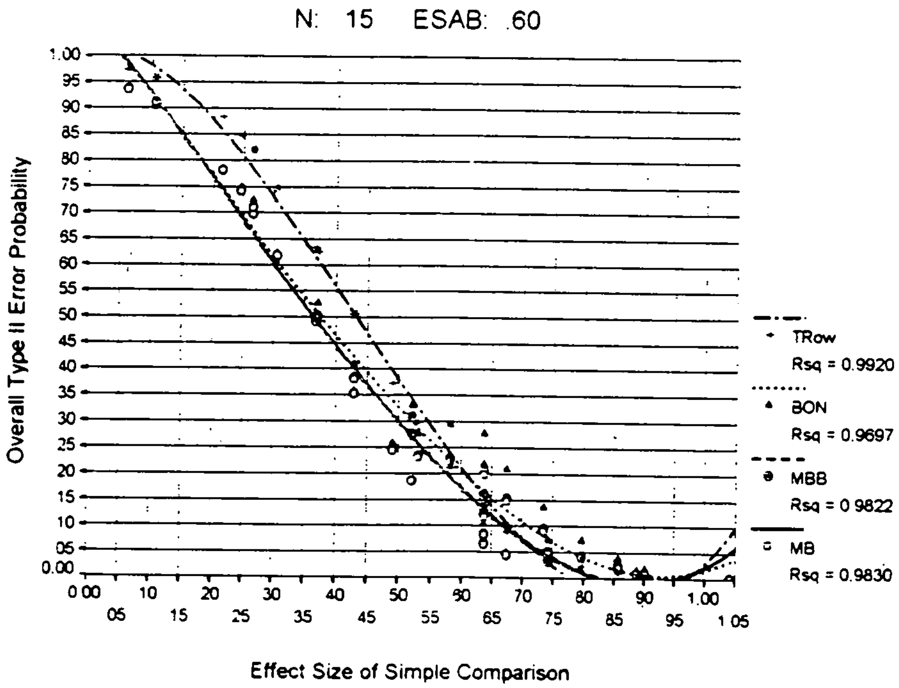


Figure 10C. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .40.

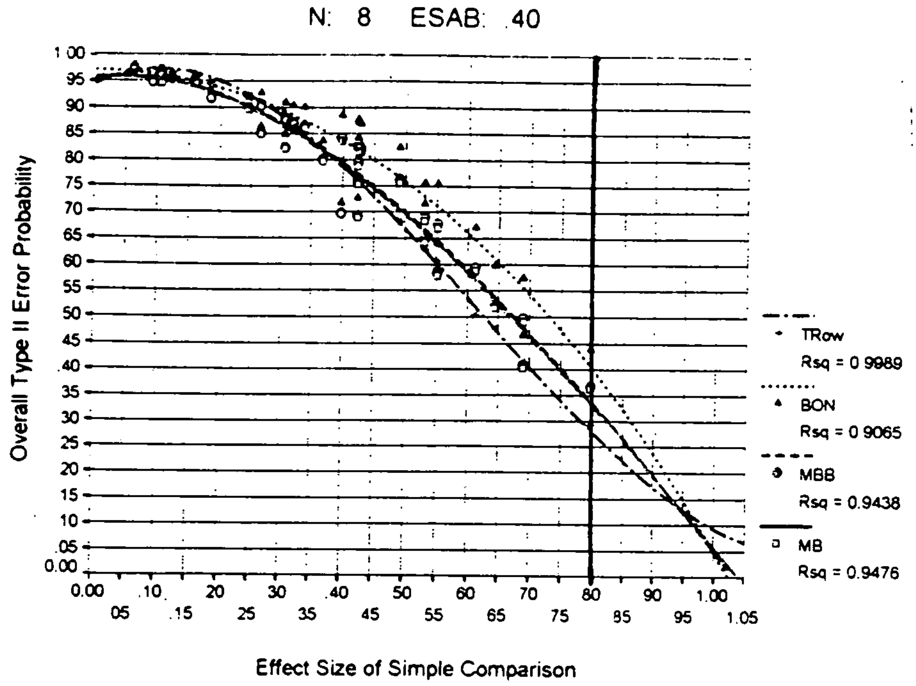


Figure 10D. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .40.

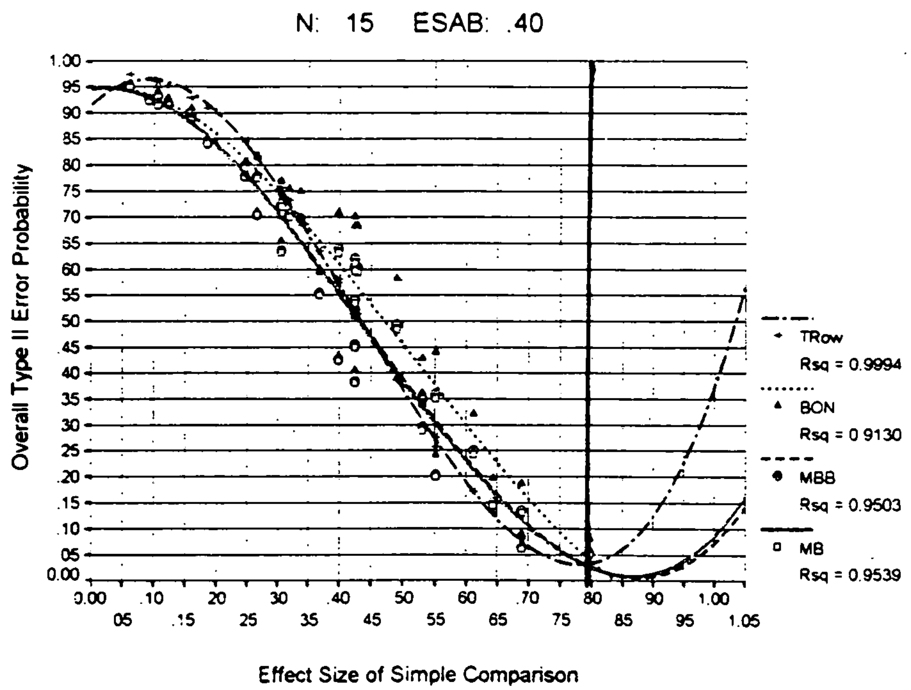


Figure 10A. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .25.

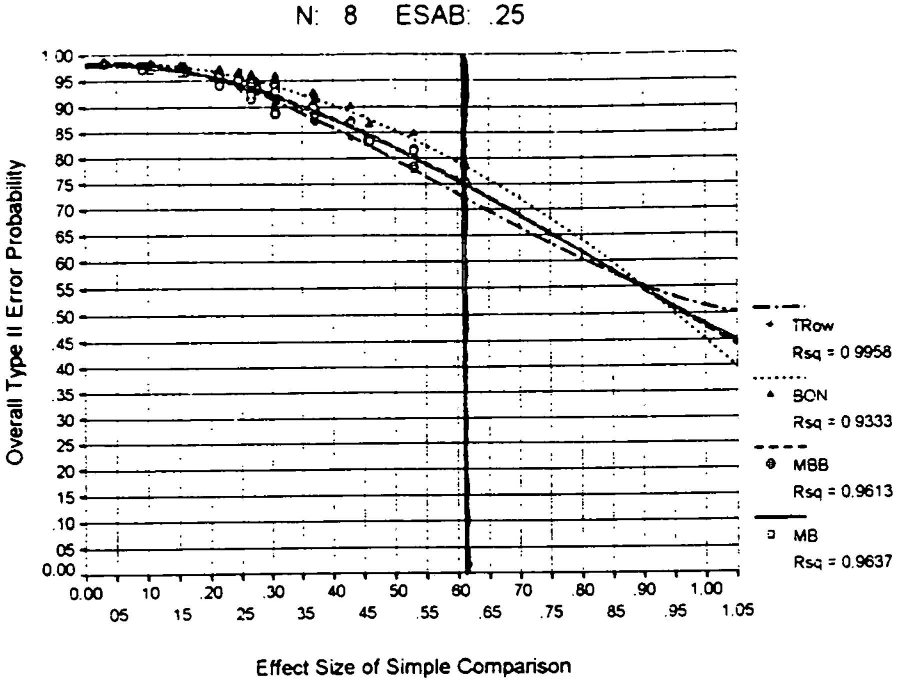
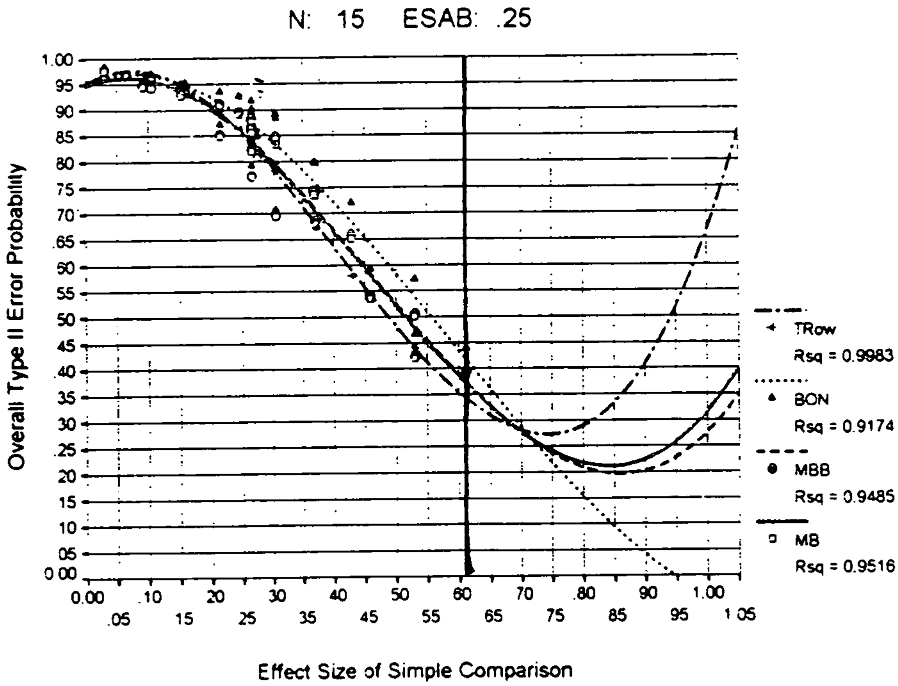


Figure 10B. Overall Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .25.



In general, as the effect size of the simple comparison increases, the difference in Type II error between these two techniques decreases. The reason for this is that the effect size for the simple comparison becomes so large, that the Tukey - Row technique, despite its penalty, is able to detect the effect.

Paying an error rate penalty at any level. The difference among all techniques which pay a penalty is the final set of comparisons among techniques. The Tukey - Row technique is compared with the three variations of the Bonferroni technique. Figures 10A to 10F present curves representing the Type II error as a function of the effect size of the simple comparison. Values for R^2 are presented in the figures. Appendix E also presents specific differences among the techniques.

The Tukey - Row technique changes its relative standing as a function of both effect size of the simple effect (because the Bonferroni techniques pay the penalty at that level) and the effect size of the simple comparison (because Tukey - Row pays a penalty at that level). In general, as the effect size of the simple effect increases, the Tukey - Row technique has a higher rate of Type II error than the Bonferroni techniques. However, as the effect size of the simple comparison increases, the Bonferroni techniques have the higher probability of Type II error. In examining Figures 10A to 10F, it can be seen that the relative standing of Tukey - Row is extremely variable.

The following observations can be made:

- the Keppel technique has a Type II error rate which is more than .05 lower than that of the Tukey - Row technique in 46% of the cases.
- the techniques do not differ in Type II error probability by more than .05 when the effect size of the interaction is moderate and n = 8.
- when the effect size of the interaction is moderate and n = 15, the difference in Type II error for the two techniques is greater than .05 when the effect size of the simple comparison is .21433. However, as the effect size of the simple comparison increases, the difference between the techniques diminishes.
- when the effect size of the interaction is large and n = 8, the difference in Type II error for the two techniques is greater than .05 when the effect size of the simple comparison is between .21433 and .74245.
- when the effect size of the interaction is large and n = 15, the difference in Type II error for the two techniques is greater than .05 when the effect size of the simple comparisons between .18372 and .55114.
- when the effect size of the interaction is very large and n = 8, the difference in Type II error for the two techniques is greater than .05 when the effect size of the simple comparison is between .21433 and .74245.
- when n = 15, the difference in Type II error for the two techniques is greater than .05 when the effect size of the simple comparison is between .10606 and .63939.

Figure 9E. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .60.

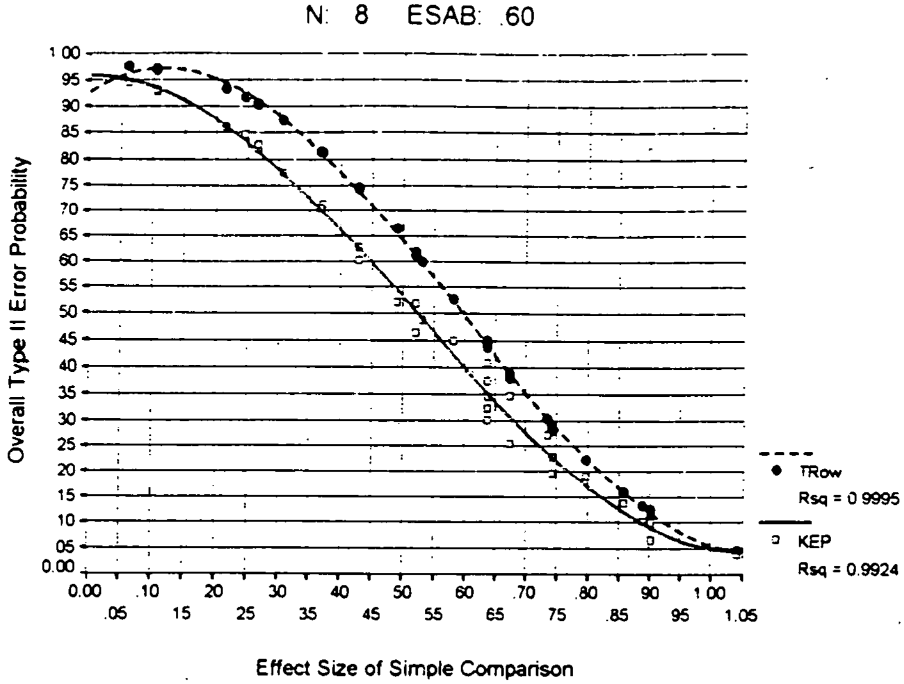


Figure 9F. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .60.

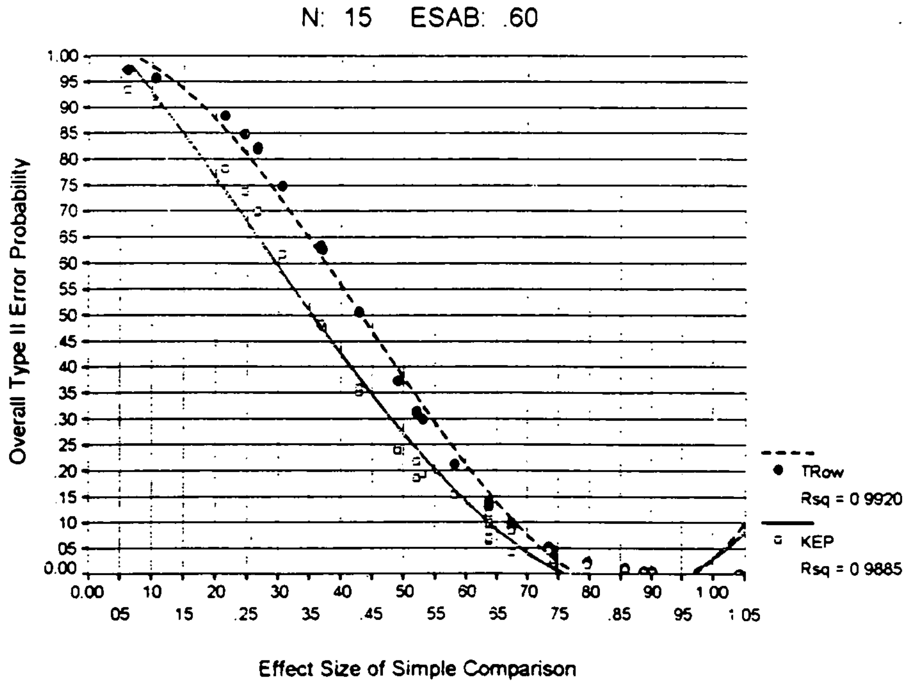


Figure 9C. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .40.

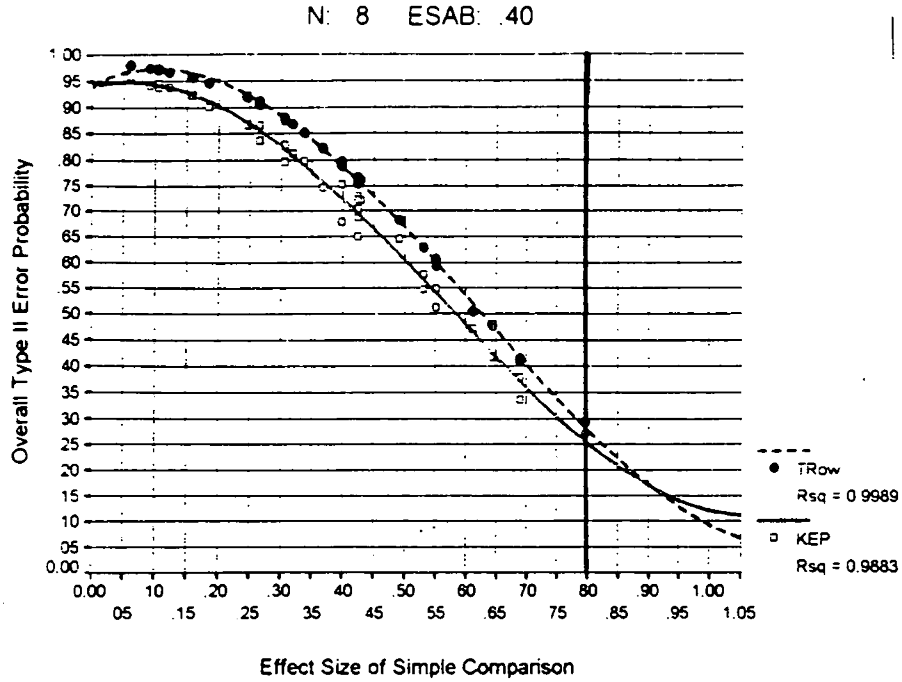


Figure 9D. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .40.

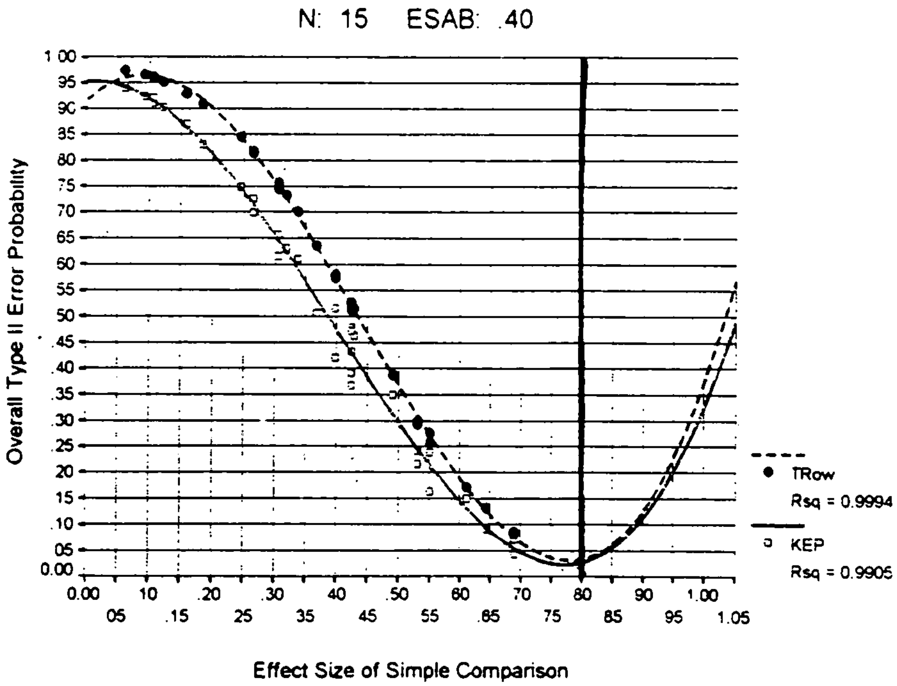


Figure 9A. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .25.

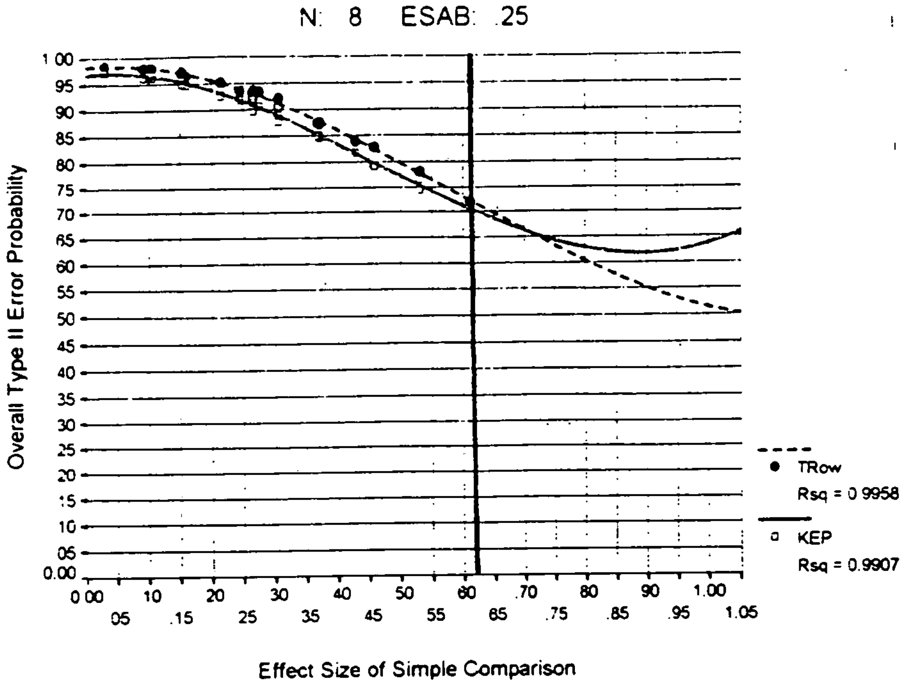
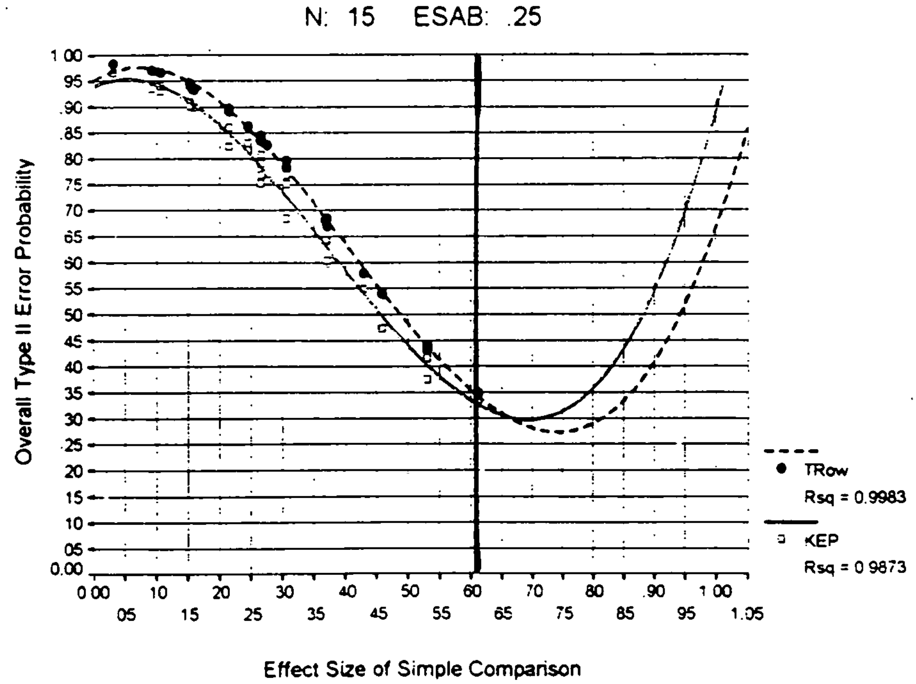


Figure 9B. Overall Type II error for the Keppel and Tukey - Row techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .25.



Bonferroni technique or the Modified Bonferroni - Both technique. The Modified Bonferroni technique and the Modified Bonferroni - Both technique never differ in Type II error by more than .05.

Paying an error rate penalty at the level of simple comparisons. The effect of paying a penalty at the level of simple comparisons can be examined by comparing the Tukey - Row technique with the Keppel technique. The only difference between these techniques is the fact that the Tukey - Row technique requires the researcher to pay a penalty. The probability of Type II error for the Keppel technique is always lower than that of the Tukey - Row technique. Figures 9A to 9F present curves representing Type II error rates for these techniques as a function of effect size of the simple comparison. Values for R^2 are presented in the figures; all curves are cubic.

probability of Type II error for Bonferroni differs by more than .05 from that of Keppel when the effect size of the simple comparison is .15910 or greater. In addition, the Modified Bonferroni and Modified Bonferroni - Both techniques differ by more than .05 from Keppel when the effect size of the simple comparison is .24495 or greater.

- when the effect size of the interaction is large regardless of sample size, the Type II error rates for all three Bonferroni techniques differ by more than .05 from that Keppel when the effect size is roughly .30000.
- when the effect size of the interaction is very large and n = 8, the probability of Type II error for Bonferroni differs by more than .05 from that of Keppel when the effect size of the simple comparison is .36742 while the probability of Type II error for Modified Bonferroni and Modified Bonferroni - Both differ by more than .05 from that Keppel when the effect size of the simple comparison is .52052 or greater.
- when n = 15, the Type II error rates for all three Bonferroni techniques differ by more than .05 from that Keppel when the effect size of the simple comparison is .52052 or greater.

From these observations, some general trends emerge. The Bonferroni techniques do, generally have a higher Type II error rate than the Keppel technique. By paying a penalty to maintain an acceptable level of familywise error, the researcher pays in terms of Type II error. Furthermore, the Bonferroni technique has a higher Type II error rate than either the Modified

both Modified Bonferroni and Modified Bonferroni - Both when the effect size of the simple comparison is .33681 or greater.

- when the effect size of the interaction is very large regardless of sample size, the probability of Type II error with Bonferroni differs by more than .05 from those of both Modified Bonferroni and Modified Bonferroni - Both when the effect size of the simple comparison is above .52052. However, when the effect size of the simple comparison is greater than .90156 and the effect size of the simple effect is .85001 or greater, differences among the Bonferroni techniques disappear when sample size is small. When sample size is large, differences disappear when the effect size of the simple comparison is greater than .67361.

When comparing the Bonferroni techniques to the Keppel technique, the following trends emerge:

- the Keppel technique has a Type II error rate which is more than .05 lower than that of the Bonferroni technique in 58% of the cases. Compared to the Modified Bonferroni and Modified Bonferroni - Both techniques, the Keppel technique has a Type II error rate which is more than .05 lower in roughly 40% of the cases.
- when the effect size of the interaction is moderate and n = 8, the probability of Type II error for Bonferroni differs by more than .05 from that of Keppel when the effect size of the simple comparison is .30619 or greater.
- when the effect size of the interaction is moderate and n = 15, the

In comparing the Bonferroni techniques with one another, the following observations can be made:

- the Modified Bonferroni and Modified Bonferroni - Both techniques never differ in Type II error by more than .05. This can be seen in Figures 8A - 8F, with the lines for these techniques overlapping one another.
- the Modified Bonferroni and Modified Bonferroni - Both techniques have Type II error rates that are more than .05 lower than that of the Bonferroni technique in roughly 30% of the cases.
- when the effect size of the interaction is moderate and n = 8, the Bonferroni techniques do not differ by greater than .05 in terms of Type II error rate.
- when the effect size of the interaction is moderate and n = 15, the probability of Type II error with Bonferroni differs by more than .05 from those of both Modified Bonferroni and Modified Bonferroni - Both when the effect size of the simple comparison is above .36742.
- when the effect size of the interaction is large and n = 8, the probability of Type II error with Bonferroni differs by more than .05 from those of both Modified Bonferroni and Modified Bonferroni - Both when the effect size of the simple comparison is above .42426 and .48990, respectively.
- when the effect size of the interaction is large and n = 15, the probability of Type II error with Bonferroni differs by more than .05 from those of

Figure 8E. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .60.

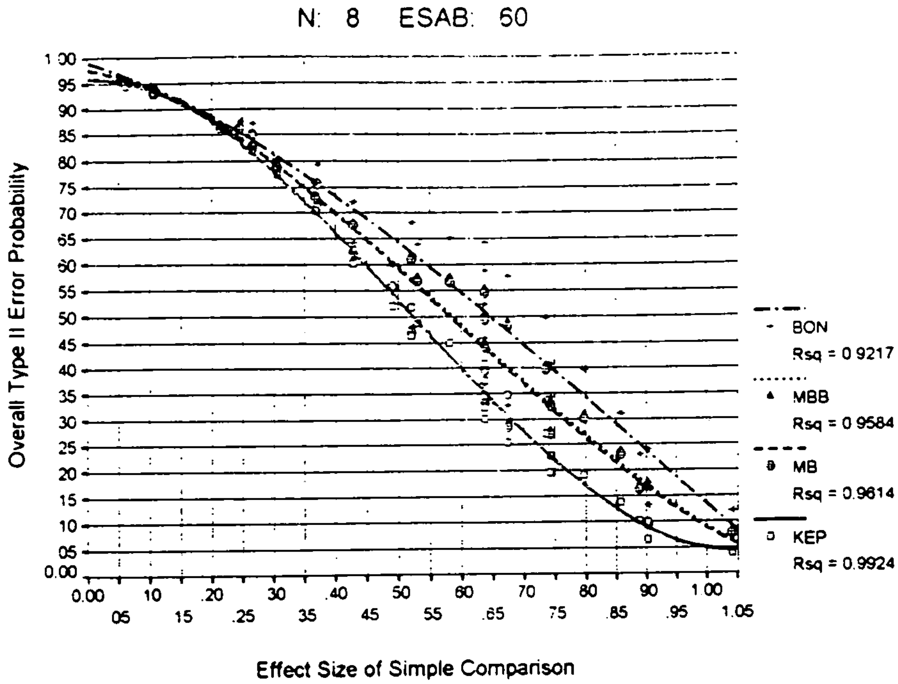


Figure 8F. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .60.

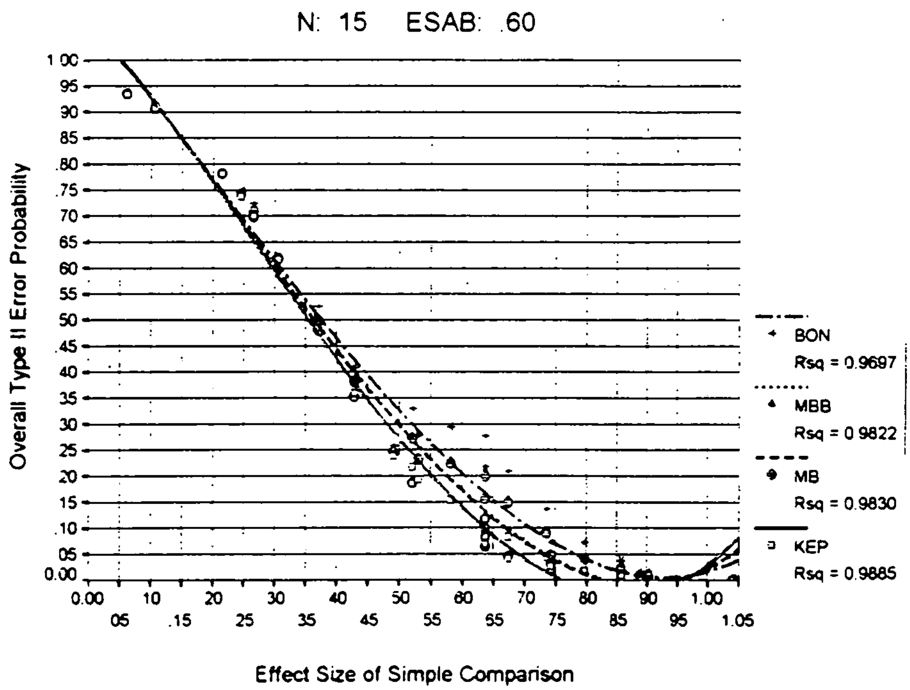


Figure 8C. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .40.

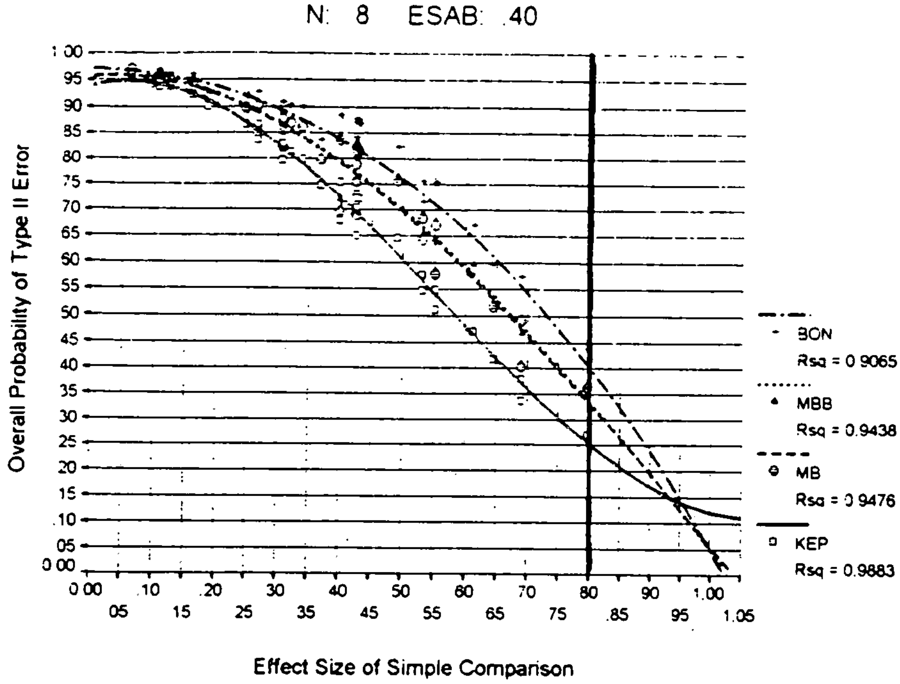


Figure 8D. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .40.

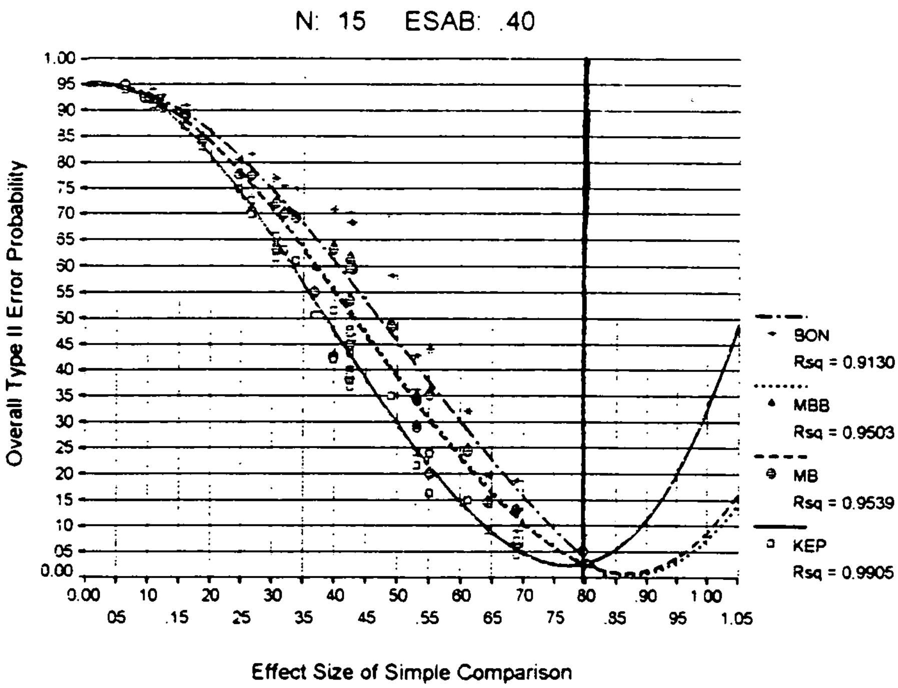


Figure 8A. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .25.

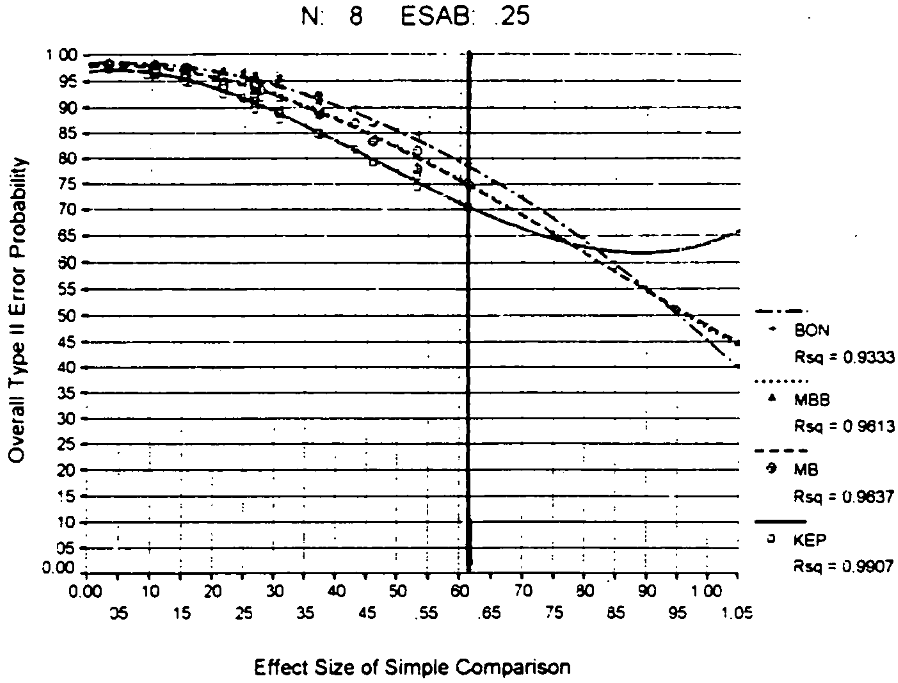
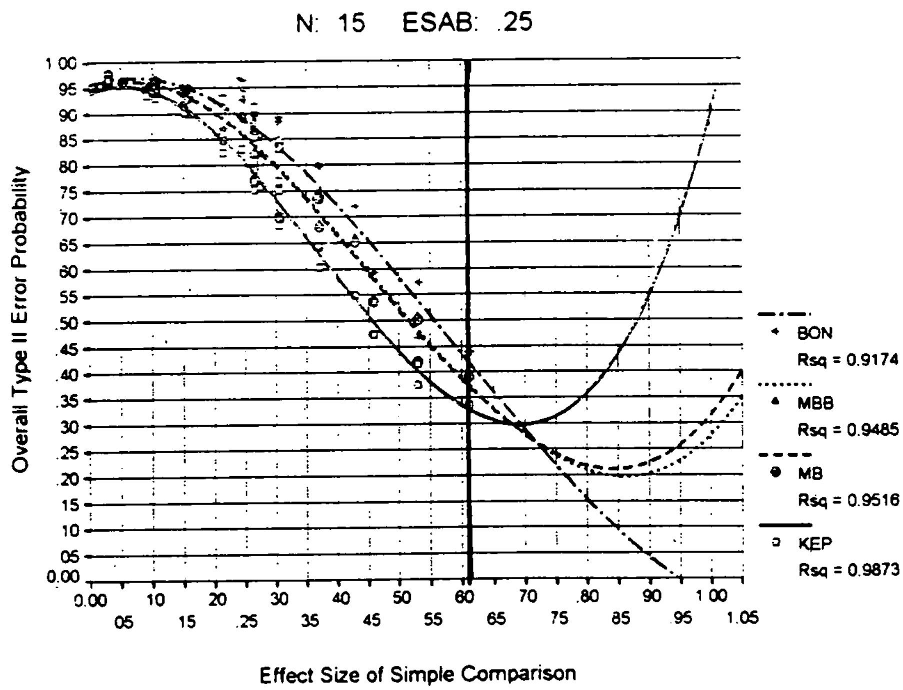


Figure 8B. Overall Type II error for the Keppel, Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .25.



Paying an error rate penalty at the level of simple effects. The effect of paying a penalty at the level of simple effects can be examined by comparing obtained Type II error rates for Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both with that of Keppel. Because all techniques conduct a test of the omnibus *F*, the analysis of simple effects, and the analysis of simple comparisons, any differences between any of the variations of the Bonferroni technique and the Keppel technique are due to the penalty. In addition, the variations of the Bonferroni technique can be compared to examine the differences in Type II error as they relate to the severity of the penalty paid. In general, the Keppel technique always has the lowest rate of Type II error, followed by the Modified Bonferroni, the Modified Bonferroni - Both, and the Bonferroni techniques.

Figures 8A to 8F show the differences in Type II error for the Bonferroni, Modified Bonferroni, Modified Bonferroni - Both, and Keppel techniques. Values for R^2 for the cubic curves fitted to the data are presented in these figures. These values for R^2 are slightly lower primarily because the techniques which pay a penalty at the level of simple effects vary as the effect size of the simple effect varies. Specific differences among these techniques are presented in Appendix E.

simple comparison is .33681 and the effect size of the simple effect is less than .50000.

- when the effect size of the interaction is very large, the Type II error probabilities for Fisher and planned comparisons do not differ by more than .05 for either sample size.
- when the effect size of the interaction is very large and n = 8, the probability of Type II error with Keppel differs by more than .05 from that of Fisher when the effect size of the simple comparison is between .52052 and .88795.
- when the effect size of the interaction is very large and n = 15, the probability of Type II error with Keppel differs by more than .05 from that Fisher at only one point (when the effect size of the simple comparison is .63639 and the effect size of the simple effect is .52202).

From these observations, some general trends emerge. Only under limited circumstances (18% of the cases) does the addition of an omnibus filter (as with Fisher) make a difference in Type II error rate. As the sample size increases and the effect size of the interaction increases, differences in Type II error due to the use of an omnibus filter become null. The addition of simple effects filter (as with Keppel) produces more differences of greater than .05 in Type II error rates (in 25% of the cases, the Keppel technique and the Fisher technique differ by more than .05).

The following observations can be made:

- when the effect size of the interaction is moderate and n = 8, the probability of Type II error with Fisher differs by more than .05 from that of planned comparisons only when the effect size of the simple comparison is greater than .21795. In addition, the Type II error probabilities for Keppel and Fisher do not differ by more than .05.
- when the effect size of the interaction is moderate and n = 15, the probability of Type II error with Fisher differs by more than .05 from that of planned comparisons only when the effect size of the simple comparison is greater than .27556. In addition, the probability of Type II error with Keppel differs by more than .05 from that of Fisher only when the effect size of the simple comparison is .24495 or greater.
- when the effect size of the interaction is large and n = 8, the Type II error rate for Fisher does not differ by more than .05 from that of planned comparisons until the effect size of the interaction is .61238 or greater. In addition, the probability of Type II error with Keppel differs by more than .05 from that of Fisher when the effect size of the simple comparison is .33681 or greater and the effect size of the simple effect is .35000 or greater.
- when the effect size of the interaction is large and n = 15, the Type II error probabilities for Fisher and planned comparison do not differ by more than .05. In addition, the probability of Type II error with Keppel differs by more than .05 from that of Fisher when the effect size of the

Figure 7E. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .60.

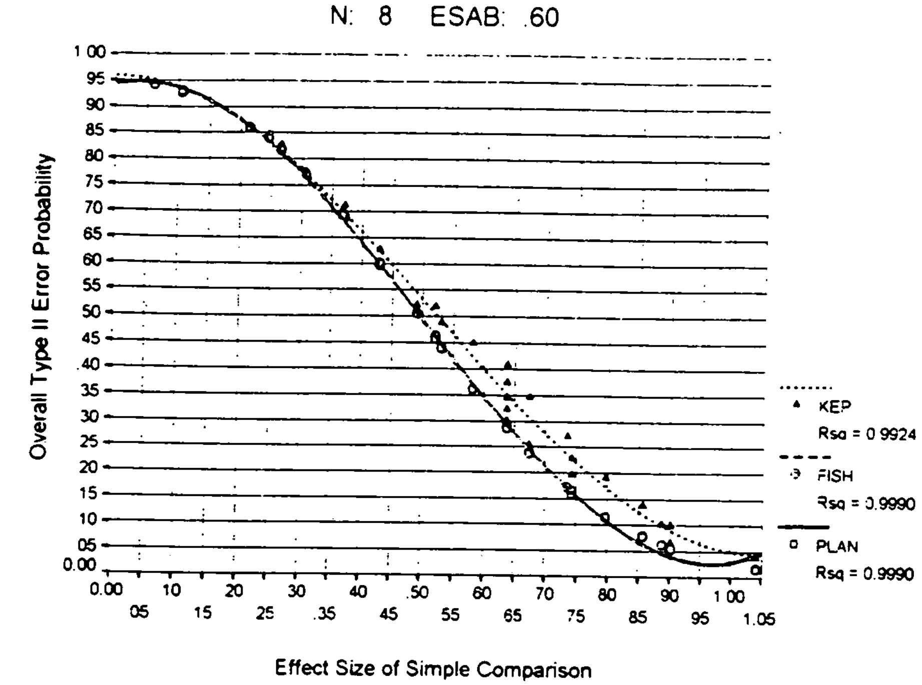


Figure 7F. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .60.

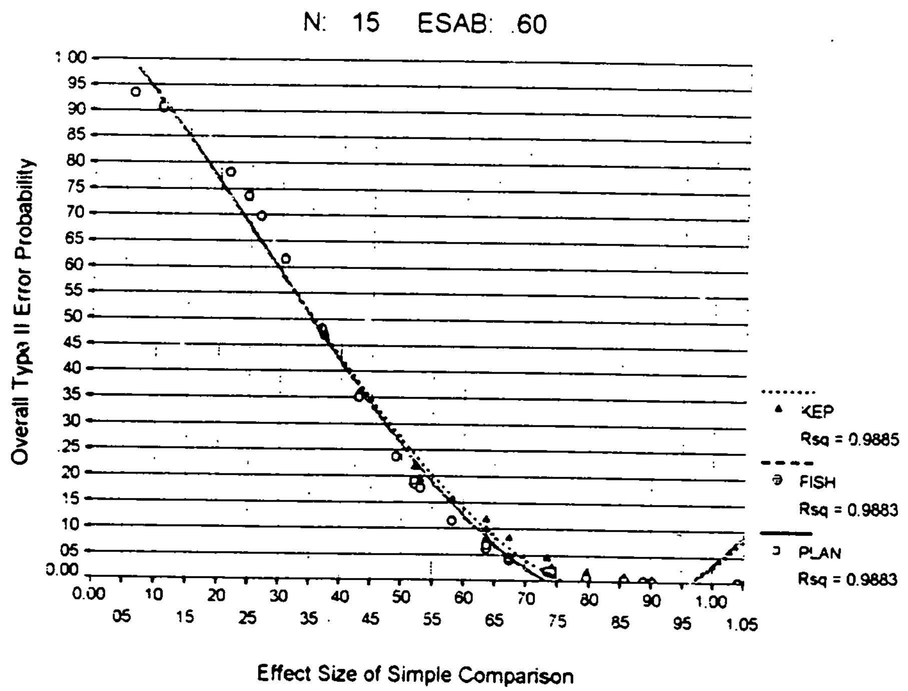


Figure 7C. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .40.

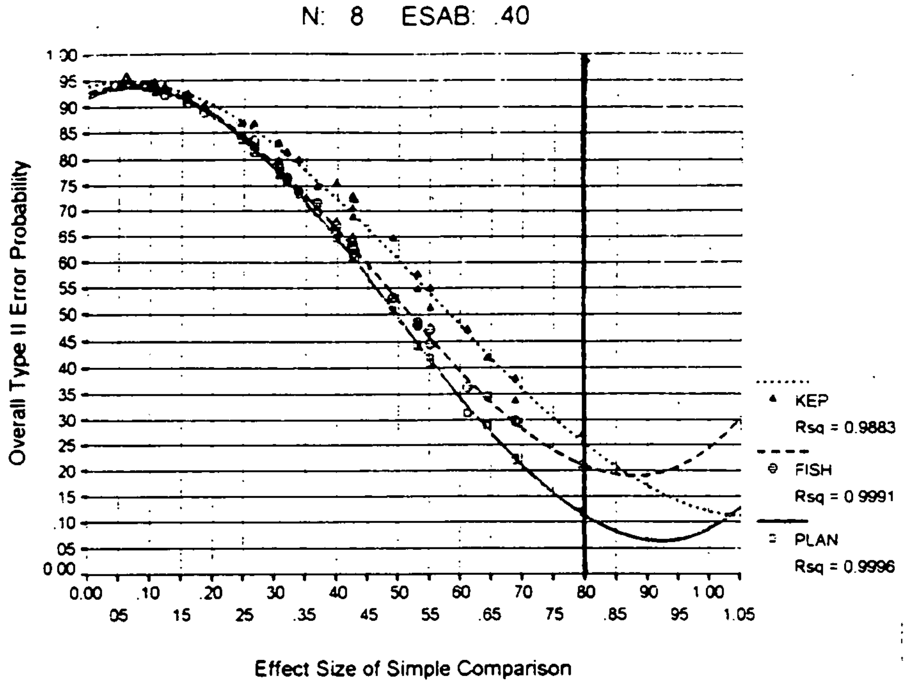


Figure 7D. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .40.

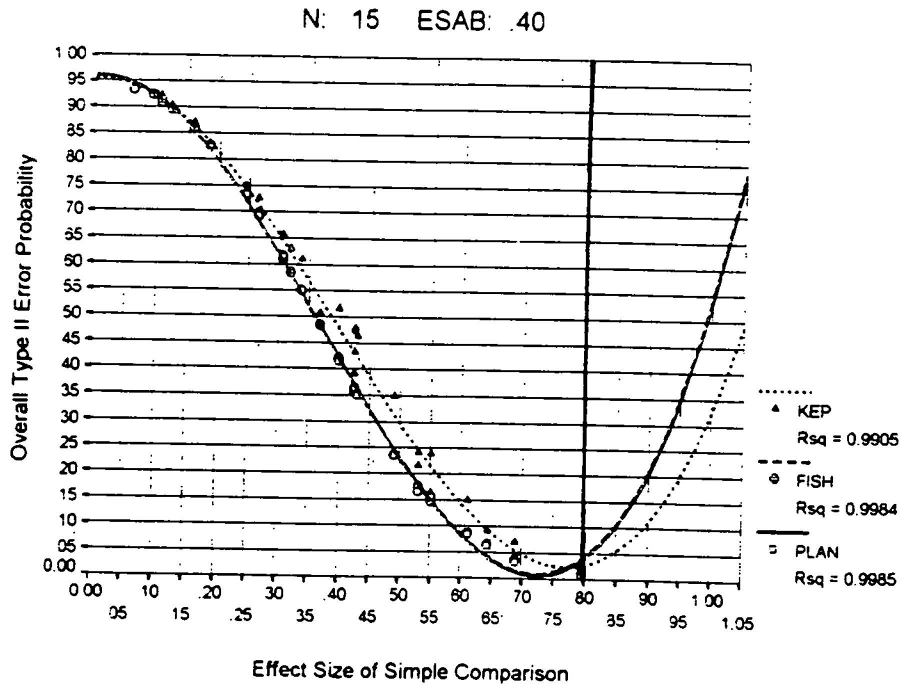


Figure 7A. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .25.

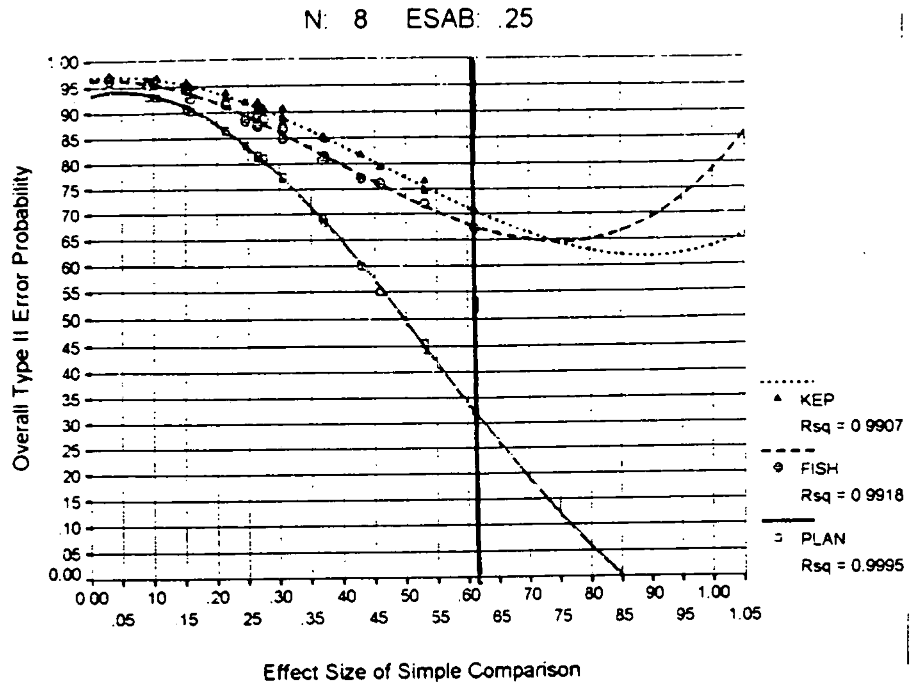
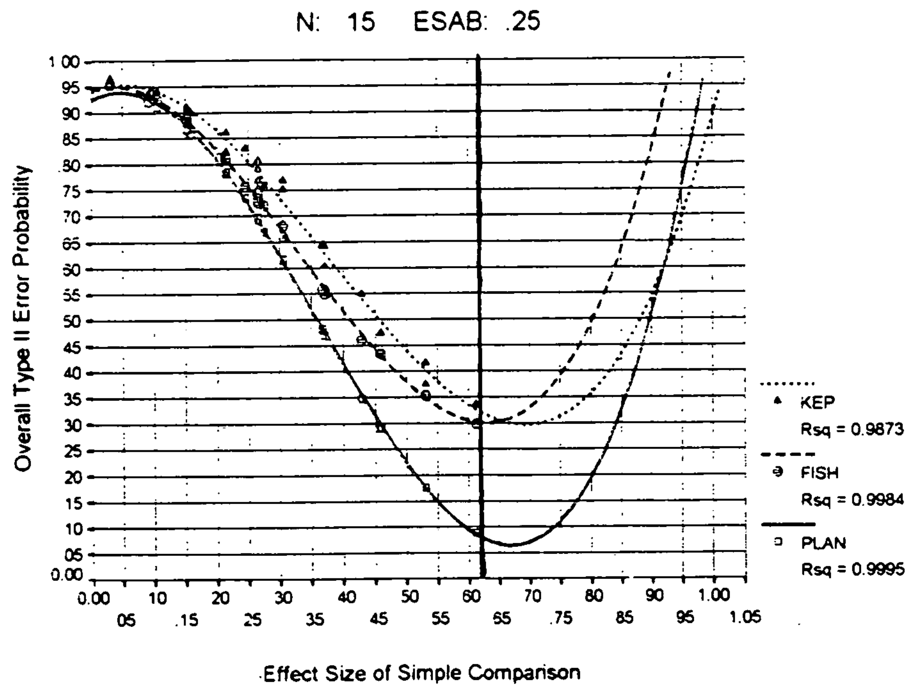


Figure 7B. Overall Type II error for filter techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .25.



planned comparisons do not have - the omnibus *F* test. The Keppel techniques has an additional layer of protection - the analysis of simple effects. A sense of the increase in Type II error rate (or loss of power) as a function the addition of these layers of protection can be garnered by comparing these three techniques. In general, the planned comparison technique has the lowest Type II error rate, followed by the Fisher technique then the Keppel technique.

Figures 7A to 7F present the overall Type II error rates for these techniques as a function of the effect size of the simple comparison. Once again, SPSS was used to fit cubic curves to the data. The values for R^2 for each line are presented in the figures. Figures 7A to 7F show where the overall Type II error rates for each of these techniques differ by more than .05 (the table in Appendix E cites specific instances of differences greater than .05).

When effect sizes of the interaction are large or very large, any of the techniques, regardless of its power, is capable of detecting the effect.

As alluded to above, differences among techniques emerge as the effect size of the interaction increases. In order to identify *meaningful* differences among techniques, a method introduced by Riesing (1993) is utilized. Riesing defined a meaningful difference in the probability of a Type II error as one which is greater than .05. The rationale for this is that researchers are willing to accept up to a 5% chance of *Type I error;* therefore, researchers should be willing to accept a difference of 5% or less in *Type II error* as negligible. This procedure was utilized because there is a lack of sufficient methods for identifying meaningful differences in Type II error. The table presented in Appendix E shows the situations in which such differences occur. The following section will present a detailed analysis of the data presented in Appendix E. Overall, 56% of the differences among techniques in Type II error rate were greater than .05. When the Tukey - Overall technique is excluded, this figure drops to 43%. In Riesing's study, only 19% of the differences among techniques were greater than .05. The differences between these studies are due to the fact that Reising used low, moderate and large effect sizes for the interaction while the present study used moderate, large and very large effect sizes. In addition, the present study examined more multiple comparison techniques than Reising's study.

<u>Filtering techniques</u>. The differential effects of applying filters can be examined by comparing the overall Type II error rates obtained for the planned comparison technique, the Fisher technique, and the Keppel technique. The Fisher technique can be viewed as having a layer of protection which the

Figures 6A to 6F show that when n = 8, differences in Type II error among the techniques (with the exception of the planned comparison approach) can be found when the interaction effect size is large ($f = .40$) or very large ($f = .60$). When n = 15, differences in Type II error among the techniques are noticeable when the effect size of the interaction is moderate ($f = .25$) or large , but not when it is very large.

In general, the multiple comparison techniques fall in a predictable order in terms of Type II error rates. Specifically, Fisher always has the lowest Type II error, followed by Keppel, Modified Bonferroni, Modified Bonferroni - Both, Bonferroni, and Tukey - Overall. The relative standing of the Tukey - Row technique varies, depending upon the effect sizes of the simple effects and the simple comparisons. Generally, in the presence of an effect size for simple comparisons which is large in relation to the effect sizes for simple effect, the Tukey - Row techniques has a lower Type II error rate than the Bonferroni techniques (Bonferroni, Modified Bonferroni, Modified Bonferroni - Both). However, if the effect size for the simple effect is greater than or equal to the effect size for the simple comparison, the Tukey - Row technique exhibits a higher Type II error rate than the Bonferroni techniques (Bonferroni, Modified Bonferroni, Modified Bonferroni - Both).

Similar to the Reising (1993) study, a convergence among techniques can be seen as the effect size of the simple comparison increases. This is particularly evident when the sample size is large and the effect size of the interaction is large or when the effect size of the interaction is very large, regardless of sample size.

Figure 6E. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .60.

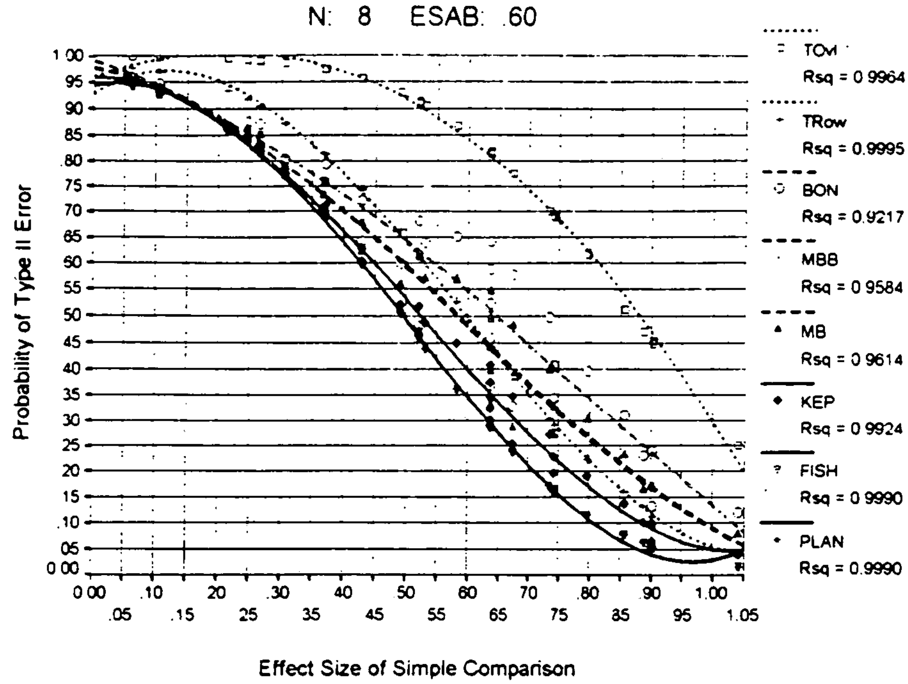


Figure 6F. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .60.

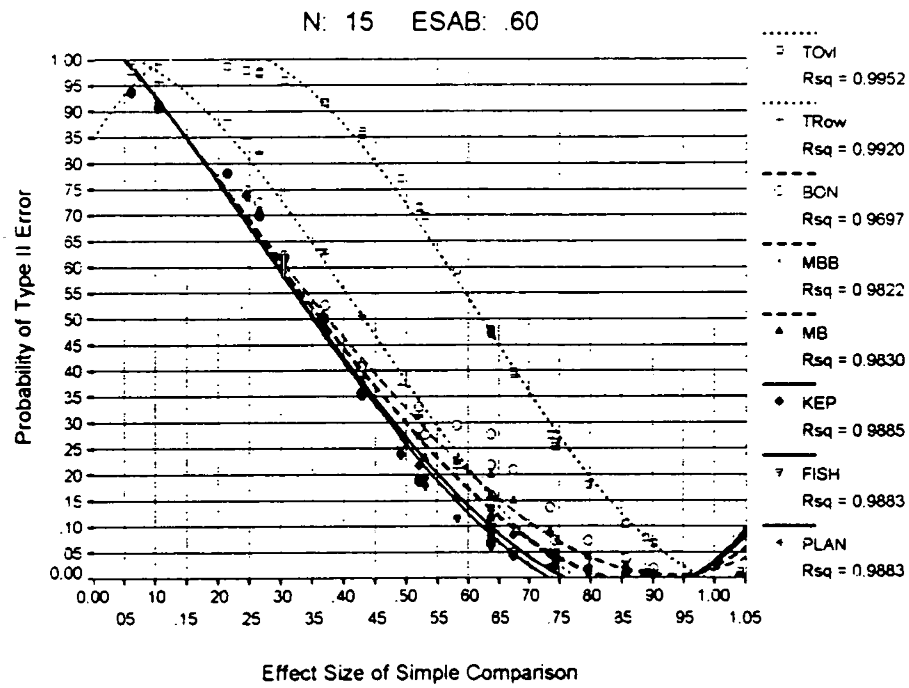


Figure 6C. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .40.

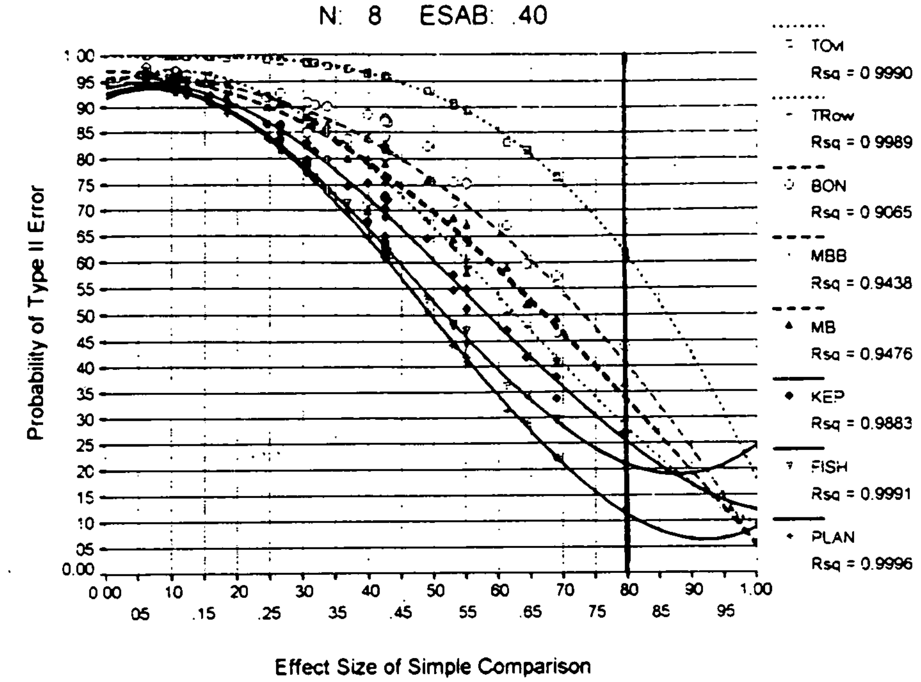


Figure 6D. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .40.

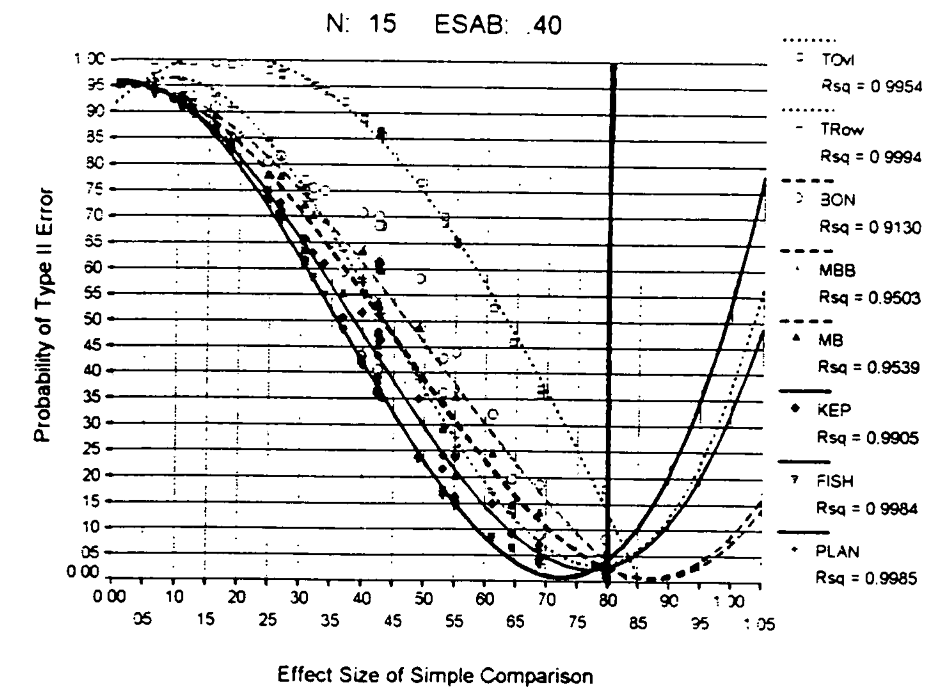


Figure 6A. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 8, ESAB = .25.

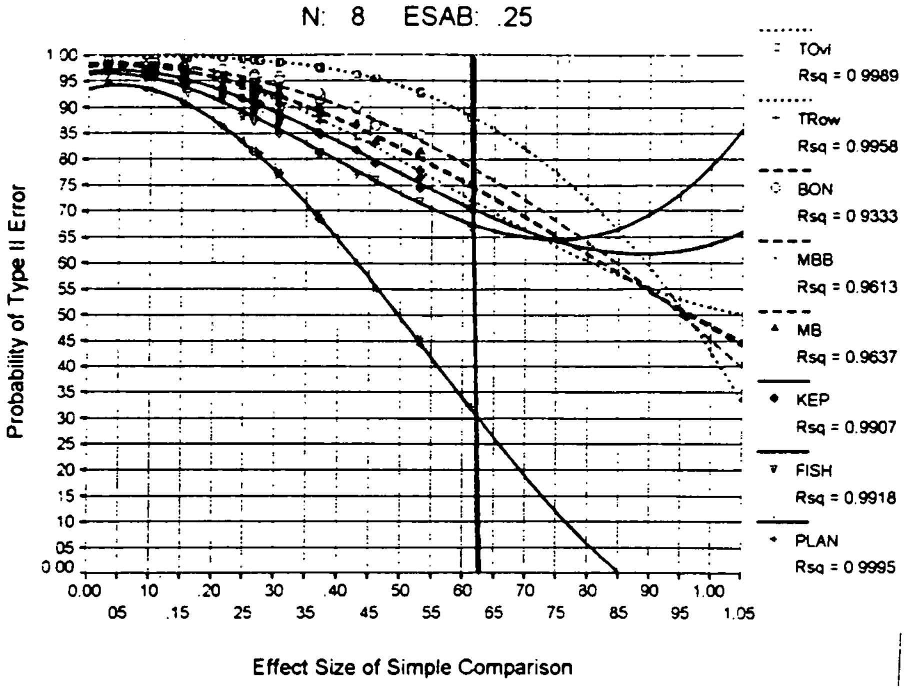
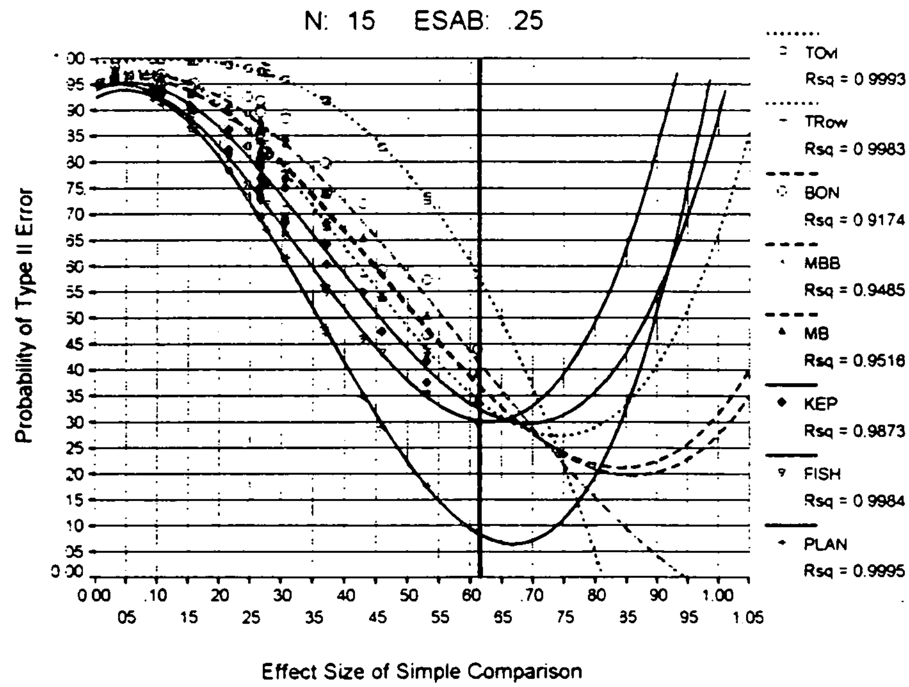


Figure 6B. Overall Type II error for all techniques as a function of the effect size of the simple comparison for n = 15, ESAB = .25.



technique is of little use to researchers. Therefore, it will be excluded from the remainder of the analyses presented in this paper.

Differences in Type II Error

As mentioned earlier, the primary purpose of this study is to identify differences in Type II error among the techniques for controlling familywise Type I error. Prior to a detailed discussion of the differences, some general trends in the data are discussed.

Figures 6A to 6F[7] show the overall Type II error probability as a function of the effect size of the simple comparison for each of the techniques. The Statistical Package for the Social Sciences (1993) was used to fit lines to the data points in these graphs. In all cases, a cubic equation was used because it offered higher values for R^2 than did linear or quadratic equations. The values for R^2 for the lines were all above .90, with many above .99; consistently, the Bonferroni technique had the lowest value of R^2. To maintain consistency, the figures were drawn on the same scale. However, when the effect size of the interaction is moderate, there is no observed data beyond a simple comparison effect size of .61238. When the effect size of the interaction is large, there is no observed data beyond a simple comparison effect size of .79609. The portion of the curves beyond these points are not valid because they are not based on empirical data. In the remainder of the figures in this paper, a solid black line is used to identify the end of data points.

[7]The remainder of the figures presented in this chapter are specific portions of Figures 6A to 6F. This is done to emphasize comparisons among certain techniques.

	A1 vs. A2	A1 vs. A3	A2 vs. A3
B1	.21433	.42866	.21433
B2	.21433	.03062	.24495
B3	.24495	.03062	.21433
B4	.09186	.27556	.36742
B5	.21433	.03062	.24495

Finally, it is important to note that the effect size of simple comparisons is affected by the effect size of the interaction, the effect size of the main effect, and the pattern of variability.

With an understanding of the computation of effect sizes for simple effects and simple comparisons, we return to the discussion of Type II error. Overall Type II error probabilities broken down by sample size, the effect size of the interaction, the effect size of the simple effect, and the effect size of the simple comparison are presented in Figures C1 - C180 in Appendix C as well as in tabular form in Appendix D. Figures C1 - C180 show the total Type II error for each of the conditions (the total height of each bar), as well as the proportion of Type II error incurred at each level of analysis. These graphs show, again, that as the effect size of the interaction increases and sample size increases, Type II error rate decreases. In addition, these graphs show that as the effect size of the simple comparison increases, Type II error rate declines.

As can be seen in Figures C1 - C180, the Tukey - Overall technique sustains an extremely high Type II error rate relative to the other techniques, resulting in very low power. Because of its low power, the Tukey - Overall

$$f = \sqrt{\frac{(-0.42866)^2 + (0)^2 + (0.42866)^2}{3}}$$

$$= 0.35000$$

It should be noted that neither the pattern of variability nor the sample size has an impact on the effect size of the simple effect. The theoretical effect sizes for all of the simple effects are presented in Appendix B.

Within each simple effect, three pairwise simple comparisons are conducted. These comparisons are conceptualized as A1 vs. A2, A1 vs. A3, and A2 vs. A3. To calculate the effect size of a simple comparison, first the difference between the levels of A being compared must be obtained. This value is then divided over the two levels. The absolute value of the result is the effect size coefficient.

As an example, once again consider the situation where the effect size of the main effect is small, the effect size of the interaction is moderate, and there is minimum variability among means. The difference among means is presented in the following matrix:

	A1 vs. A2	A1 vs. A3	A2 vs. A3
B1	-0.42866	-0.85732	-0.42866
B2	-0.42866	0.06125	0.48991
B3	0.48991	0.06125	-0.42866
B4	0.18372	-0.55113	-0.73485
B5	-0.42866	0.06125	0.48991

The effect size for each of the simple comparisons is presented in this matrix:

interaction, and the pattern of variability has an effect size coefficient matrix associated with it. Chapter I outlined the calculation of the coefficients and the construction of these matrices. These matrices are presented in Appendix B.

For each simple effect, an effect size, *f*, can be calculated using Cohen's (1988) effect size index formula. Recall from Chapter I, when the population mean is zero, as in the studies presented here, *f* can be calculated as follows:

$$f = \sqrt{\frac{\sum (\mu_i)^2}{k}}$$

where:

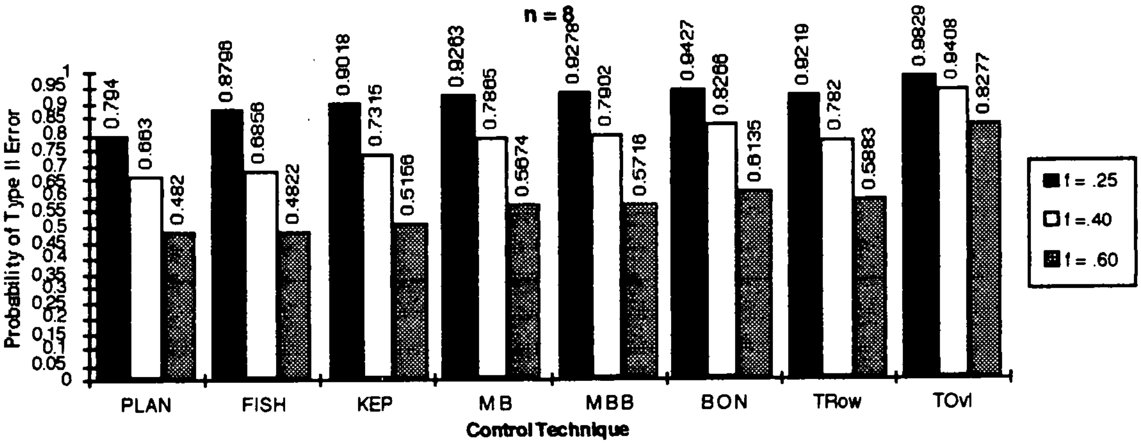
μ_i is the mean for a given group in the population and

k is the number of means.

In calculating the effect size of the simple effect, the effect size coefficients from a given row in a matrix are used for μ_i. Because there are three means per simple comparison, $k = 3$. For example, when the effect size of the main effect is small, the effect size of the interaction is moderate, and there is minimum variability among means, the following matrix is used:

	A1	A2	A3
B1	-0.42866	0	0.42866
B2	-0.12247	0.30619	-0.18372
B3	0.18372	-0.30619	0.12247
B4	-0.12247	-0.30619	0.42866
B5	-0.12247	0.30619	-0.18372

The effect size of the simple effect for the first simple effect (the first row in this matrix) is calculated as follows:



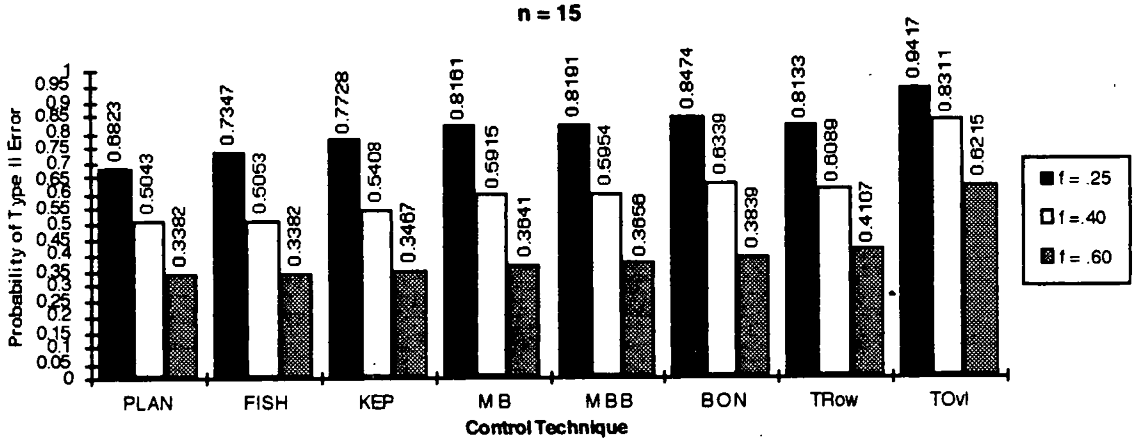


Figure 5. Overall Type II error rates for each combination of effect size of the interaction and sample size.

Finally, the effect sizes of the simple effect and the simple comparison have an influence on Type II error. Therefore, the data were further broken down to incorporate these variables. Before presenting these data, however, further explanation of the calculation of the effect size of the simple effects and the effect size of the simple comparisons is necessary.

Each combination of the effect size of the main effect, the effect size of the

effect size of the interaction. The reader must bear in mind that moderate and large effect sizes for the interaction were used in addition to the very large effect size. Cohen (1988) points out that even moderate and large effect sizes may result in low statistical power (and a high rate of Type II error).

Because both sample size and the effect size of the interaction influence Type II error rate, the overall Type II error data broken down by these variables is presented in Figure 5. In addition to showing differences in Type II error rates among techniques (as in Table 7 above), Figure 5 shows the effect of sample size and effect size of the interaction. As the sample size increases, the overall Type II error rate declines. Similarly, as the effect size for the interaction increases, the overall Type II error rate declines. In addition, Figure 5 shows that the magnitude of the differences among the techniques in terms of Type II error decreases as the effect size of the interaction increases as well as when the sample size increases. These changes can be seen for all techniques. For example, the difference between the planned comparison approach and the Keppel technique drops from approximately .11 when n = 8 and the effect size of the interaction is moderate to less than .01 when n = 15 and the effect size of the interaction is very large.

comparisons technique, the Fisher technique, and the Keppel technique are relatively small. The Keppel technique shows a difference in Type II error of only roughly .05 from the planned comparison approach, and of only roughly .03 from the Fisher technique. Furthermore, the Tukey - Overall technique show substantially greater Type II error than any other technique (roughly .15 greater than the Bonferroni technique, which has the second highest rate of Type II error). When the Tukey - Overall technique is excluded, the difference between the post-hoc multiple comparison techniques offering the highest and lowest Type II error rates is approximately .11. Finally, given the inverse relationship between Type I and Type II error, the ordering of the techniques by overall Type II error rate is consistent with what is expected (in accordance with the results of Study 1).

Table 7. Overall Type II error rates.

Control Technique	Overall Probability of Type II Error
Planned Comparisons	0.5711
Fisher	0.5965
Keppel	0.6271
Modified Bonferroni	0.6678
Modified Bonferroni - Both	0.6708
Bonferroni	0.7008
Tukey - Row	0.6806
Tukey - Overall	0.8536

At first glance, the overall Type II error rates presented in Table 7 appear to be high. However, these values are collapsed across both sample size and

require the researcher to pay a penalty at the level simple effects? Furthermore, what is the difference among these techniques and one which does not pay a penalty at the level of simple effects?

(3) What is the difference in Type II error among the techniques which require the researcher to pay a penalty at the level of simple comparisons? What is the difference among these techniques and one which does not pay a penalty at the level of simple comparisons?

(4) What is the difference in Type II error among the techniques which require the researcher to pay a penalty?

Finally, the discussion returns to Type I error. However, the discussion concentrates on Type I error at the level of simple comparisons within the context of true treatment effects.

Overall Type II Error

The number of significant results at each level of analysis was subtracted from 10,000 for each 36 condition used in Study 2. This value was converted to a probability and serves as a measure of Type II error for each of the levels of analysis. These values were accrued to obtain an overall probability of Type II error within an experiment. The average Type II error probabilities for each of the seven techniques as well as the planned comparison technique are presented in Table 7.

As Table 7 shows, the techniques fall in the expected pattern in terms of overall Type II error. Interestingly, at this level, differences among the planned

4. As Figure 4 shows, the overall Type II error rate refers to the sum of Type II errors incurred at each level of analysis.

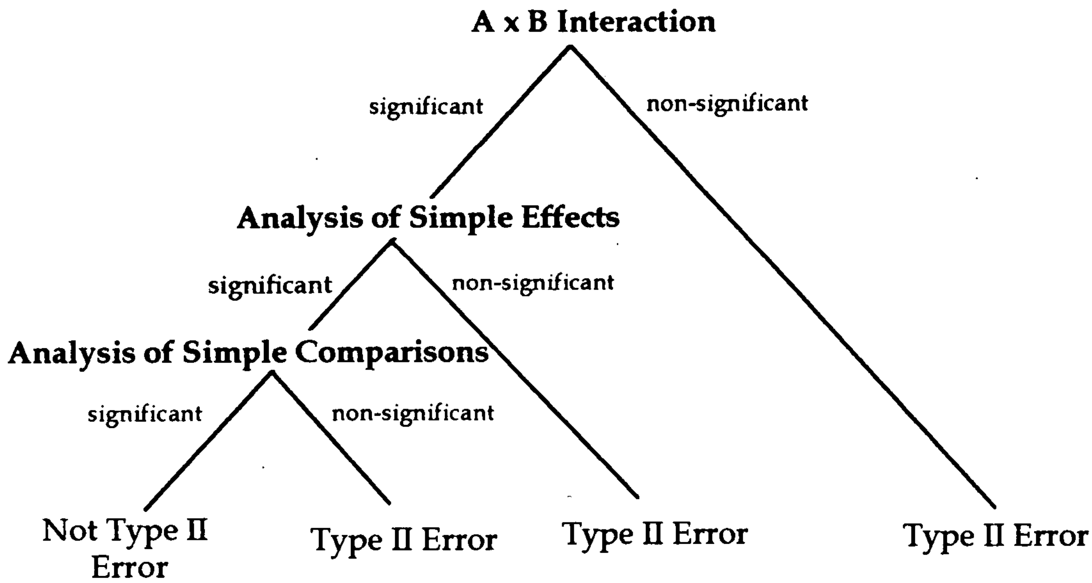


Figure 4. A tree diagram depicting the stages of analysis which can produce Type II errors (adapted from Riesing, 1993).

The first section deals with the overall probability of Type II error. The second section deals with differences in Type II error among the seven techniques. In an effort to control the complexity of these results, the second section is further divided into four subsections. Each of these subsections deals with a subset of the seven techniques in order to answer the following research questions:

(1) What is the difference in Type II error among the techniques which utilize a filtering strategy without any error rate penalty?

(2) What is the difference in Type II error among the techniques which

effects analyses are conducted).

Omnibus *F* tests for the A x B interaction were conducted by the program. Given the addition of treatment effect to the random data, all of the experiments should produce a significant interaction. Those cases in which the interaction is found non-significant represent Type II error. Analyses of simple effects followed the omnibus analysis. Simple effects were conducted only one way (variable A was examined for each level of variable B). A total of five simple effects were conducted for each significant omnibus *F* (corresponding to the number of levels of variable B). Furthermore, for each significant simple effect, three pairwise simple comparisons were conducted. At each level of analysis, obtained *F* probabilities were recorded to a data file.

A second program analyzed the data in these files. This program conducted analyses of simple effects and simple comparisons, applying each of the seven techniques for the control of compounding familywise error. This program used the ANOVA contingency analysis strategy (performing analyses contingent upon significance at a higher level of analysis). Therefore, for every significant omnibus *F*, five simple effects were tested and for each of these simple effects that were significant, three simple pairwise comparisons were conducted (except in the cases of Fisher and Tukey-Overall where the analysis of simple effects is not conducted).

Results and Discussion

The results of Study 2 center on overall Type II error rates for the seven techniques. Overall Type II error can be better understood by examining Figure

Finally, two patterns of variability among treatment means were used: minimum variability and maximum variability[6]. It is important to bear in mind that the specific pattern does not affect the omnibus *F* test nor the analysis of simple effects because the effect size is distributed across an effect. However, pattern of variability does affect the analysis of simple comparisons. In this study, pattern of variability was manipulated to produce a variety of effect sizes for the simple comparisons.

Procedure

The Monte Carlo simulation computer program employed in Study 1 was used to randomly generate data for the 10,000 3 x 5 between subjects factorial experiments for each of the 36 conditions in the 2 (sample size) x 3 (effect size of main effect) x 3 (effect size of interaction) x 2 (pattern of variability) factorial combination of independent variables. The simulation program allowed for the entry of effect for the main effect and the interaction (the matrices containing the effect size coefficients for each pattern of variability are presented in Appendix B).

Following generation, the data were submitted to a series of programs which conducted statistical analyses. As in Study 1, seven methods for controlling familywise Type I error were applied to the data in these programs. In addition, all possible pairwise comparisons were conducted on the data (analogous to the planned comparison procedure where no omnibus of simple

[6]Only minimum and maximum variability patterns will be used in this study. The moderate variability pattern produces effect size matrices which are identical to those of the minimum variability pattern for a 3 x 5 design.

power to detect true treatment effects. To examine Type II error, treatment effects must be added to randomly generated data. In Study 2, treatment effects were added for both the main effect of variable A and the interaction effect of A x B. In addition, the pattern of variability among treatment means and sample size were manipulated. Each of these independent variables is described below.

Design

The manipulation of four variables (sample size, effect size of the main effect, effect size of the interaction, and pattern of variability) produces a 2 x 3 x 3 x 2 design for Study 2. As in Study 1, normally distributed data were randomly generated such that half of the experiments have a cell size of 8 (small n) and the remaining half have a cell size of 15 (large n).

Effects for the main effect of A and the interaction effect of A x B were added to the randomly generated data to produce the true treatment effects necessary to study Type II error. The effect size of the main effect of A has three level: null, small, and moderate designated by $f = .00$, $f = .10$, and $f = .25$, respectively. This nomenclature for effect sizes is consistent with Cohen (1988). The effect size of the main effect was manipulated for the sole purpose of obtaining a variety of effect sizes for the simple effects and simple comparisons. Therefore, no analyses will involve this variable. The effect size of the A x B interaction also has three levels: moderate, large, and very large, designated by $f = .25$, $f = .40$, and $f = .60$, respectively.

CHAPTER III

STUDY 2: TYPE II ERROR AND THE POWER TO DETECT TRUE EFFECTS

Study 2 focuses on the Type II error rates and power of the same seven techniques used to control the compounding of familywise Type I error in Study 1. A Type II error occurs when a true treatment effect exists, but statistical tests produce non-significant results. Power, in turn, is defined as the likelihood of obtaining a statistically significant result when a true treatment effect exists. Given that power is computed as $1 - \beta$ (where β is the probability of Type II error), the concept of power is directly related to Type II error. Throughout Study 2, the reader should bear in mind the relationship between Type II error and power.

Study 2 specifically attempts to quantify the magnitude of the differences among the seven techniques in terms of Type II error. The Type II error rates for each of the techniques can then be used to compute the power of each to detect a true effect.

Method

Given that Study 1 showed that all seven techniques under examination maintain an excepable level for familywise Type I error, the focus shifts to differences among these techniques in terms of Type II error and the statistical

.4781) to the probabilities obtained for all of the correction techniques ($p < .05$). Thus, when no control technique is utilized, there is nearly a 50% chance of creating at least one Type I error.

By comparing this empirical value for α_{FW} to its corresponding theoretical value, the reliability of the Monte Carlo generator may once again be checked. As demonstrated in the Introduction, the theoretical value of α_{FW} can be computed using the following formula:

$$\alpha\text{FW} = 1 - (1 - \alpha)^c$$

where:

c = the number of statistical tests.

In a 3 x 5 factorial design, a total of fifteen possible pairwise comparisons exist. Therefore, the theoretical value of α_{FW} is computed as follows:

$$\alpha\text{FW} = 1 - (1 - .05)^{15}$$

$$= .5367.$$

There is a slight discrepancy between the empirical α_{FW} and the theoretical value. However, as Keppel (1991) and Kirk (1982) point out, the actual value of α_{FW} will be less than or equal to this theoretical value when nonorthogonal, non-independent comparisons are made (as is the case in the present study).

Table 6. Familywise Type I error rates.

Control Technique	Sample Size 8	15
Planned Comparisons	0.4765	0.4781
Fisher	0.0505	0.0495
Keppel	0.0469	0.0455
Modified Bonferroni	0.0347	0.0302
Modified Bonferroni - Both	0.0338	0.0311
Bonferroni	0.0248	0.0222
Tukey - Row	0.0456	0.0432
Tukey - Overall	0.0071	0.0070

The results follow a predictable pattern: in general, those techniques which apply a more rigid correction show lower familywise Type I error rates. Specifically, the techniques fall in the following order from lowest to highest familywise Type I error rate: (1) Tukey-Overall, (2) Bonferroni, (3) Modified Bonferroni - Both, (4) Modified Bonferroni, (5) Tukey-Row, (6) Keppel, and (7) Fisher. In addition, error rates are, again, slightly lower for larger sample sizes.

Given the fact that all of the techniques (with the exception of Fisher when n = 8) exerted an acceptable level of control over the compounding of Type I error, the primary question of interest becomes: "which techniques offer researchers the greatest amount of statistical power by limiting the amount of Type II error?" This is the focus in Study 2.

Finally, the results of Study 1 show that the application of *any* of these techniques greatly reduces the chance of committing at least one Type I error. This is demonstrated by comparing the probability for planned comparisons (p =

the least stringent correction technique, there is only a 1% chance of committing a Type I error.

Further support for the reliability of the Monte Carlo generation program can be found in the results of the planned comparisons. Theoretically, when directly testing comparisons with $\alpha_{PC} = .05$ when no filtering technique was utilized (as with planned comparisons), 5% of the tests should yield Type I errors. Empirically, approximately 5% of these uncorrected pairwise comparisons produced significant results.

Familywise Type I Error

Familywise Type I error was calculated by summing the number of occurrences of at least one significant simple comparisons in an interaction family within an experiment (with fifteen possible pairwise comparisons). This was converted to a probability (by dividing the total by 10,000). Familywise Type I error rates were computed for seven techniques as well as for a method testing all possible pairwise comparisons (not applying the contingency analysis plan). The results for both sample sizes are presented in Table 6.

The most important result from this study is that all of the techniques maintained a familywise Type I error rate within the acceptable limits ($p \leq .05$) with the exception of Fisher when $n = 8$ ($p = .0505$). However, given the fact that the empirical Type I error rate at the omnibus level when $n = 8$ was .0506, α_{FW} may have exceeded .05 with the Fisher technique because the Monte Carlo generator produced data which yielded Type I error rates which were slightly high to begin with.

number of significant simple comparisons and converting this to a probability. The probability of Type I error per simple comparison for each of the seven techniques is presented in Table 5 along with the probability of Type I error in the case of all uncorrected pairwise comparison (PLAN; i.e., planned comparisons).

Table 5. Type I error rates per simple comparison.

Control Technique	Sample Size 8	Sample Size 15
Planned Comparisons	0.0507	0.0511
Fisher	0.0097	0.0094
Keppel	0.0070	0.0068
Modified Bonferroni	0.0046	0.0042
Modified Bonferroni - Both	0.0045	0.0041
Bonferroni	0.0032	0.0029
Tukey - Row	0.0053	0.0050
Tukey - Overall	0.0005	0.0005

The results show a predictable pattern in which techniques paying greater penalties commit the fewer Type I errors. Namely, the rank ordering of the techniques from lowest to highest Type I error rates is: (1) Tukey - Overall (TOvl), (2), Bonferroni (BON), (3) Modified Bonferroni - Both (MBB), (4) Modified Bonferroni (MB), (5) Tukey - Row (TRow), (6) Keppel (KEP), and (7) Fisher (FISH). Obviously, the planned comparison techniques yielded a higher Type I error rate than any of these techniques because it applies no form of correction. Given these results, it is clear that with all of the correction techniques, there is a very small probability of committing a Type I error at the level of simple comparisons compared to the planned comparison procedure. Even with Fisher,

with other Monte Carlo studies which provide only descriptive results (e.g., Bradley, 1980; Keselman & Keselman, 1987; Reising, 1993; Rosnow & Rosenthal, 1989). The rationale behind this approach is that given the tremendous sample size (each condition has 10,000 data points) and the inherent power, all inferential statistical analyses would produce significant results regardless of the size of the differences (Reising, 1993).

Omnibus Analysis of the Interaction

Significant interactions were counted by the Monte Carlo generation program and converted to probabilities. These numbers represent the probability of Type I error and are presented in Table 4. These results can be used to validate the reliability of the Monte Carlo generation program. As can be seen, approximately 5% of the experiments yielded Type I error. In other words, given no treatment effects, randomly generated data were found to be statistically significant in 5% of the cases (corresponding to the critical probability value, $p \leq .05$). Type I error is slightly lower for the larger sample size.

Table 4. Type I error rates for the omnibus test of the A x B interaction.

Sample Size	**Type I Error Probability**
8	0.0506
15	0.0495

Type I Error per Simple Comparison

Type I error was calculated for each simple comparison by summing the

each condition) should yield a significant interaction. Because no actual treatment effect is operating, these experiments represent cases of Type I error.

Analyses of simple effects were computed following the omnibus analysis. Simple effects were conducted only one way (variable A was examined for each level of variable B). A total of five simple effects were conducted in each of the simulated experiments (corresponding to the number of levels of variable B). For each simple effect, three pairwise simple comparisons were conducted. At each level of analysis, obtained *F* probabilities were recorded to a data file.

A second program analyzed the data in these files. This program conducted analyses of simple effects and simple comparisons, applying each of the seven techniques for the control of compounding familywise error (Fisher, Keppel, Modified Bonferroni, Modified Bonferroni - Both, Bonferroni, Tukey - Row, and Tukey - Overall) as well as planned comparisons. In this program, for every significant omnibus *F*, five simple effects were tested and for each of these simple effects that were significant, three simple pairwise comparisons were conducted, but only in accordance with the analysis strategy of the individual techniques (for example, for the Fisher and Tukey-Overall techniques, the analysis of simple effects was not conducted).

Results and Discussion

The results of Study 1 are presented in three sections: (1) Type I error at the omnibus analysis of the interaction, (2) Type I error per simple comparison, and (3) familywise Type I error at the analysis of simple comparisons.

No statistical analyses will be reported in this paper. This is consistent

comparison filters) was used to analyze the data.

Design

In Study 1, one independent variable was manipulated - sample size. Both overall Type I error (the likelihood of a Type I error per simple comparisons) and familywise Type I error (the likelihood of at least one Type I error within a family of tests) were measured for each of the seven control techniques described earlier. For comparison purposes, a method which applies no control (conducting all possible pairwise comparisons without utilizing the ANOVA contingency analysis strategy) is also presented. This techniques is similar to performing planned comparisons on all of the possible pairs of individual cell means.

Procedure

The Monte Carlo simulation programs used to randomly generate data employed the polar method for normal deviates algorithm (Knuth, 1973). With this algorithm, data were generated to be normally distributed with a mean of 0 and a standard deviation of 1. In addition, the program allowed for entering of effect sizes of both the main effect of A and the interaction effect of A x B. In this study, however, because the focus is on Type I error, null effect sizes were enter for both the main effects and the interaction.

Omnibus F tests were conducted by the program obtaining the A x B interaction. Given the use of merely random data in this study, only approximately 5% of the experiments (about 500 of the 10,000 experiments in

Bonferroni technique (specific details about each technique are presented in Chapter I). Finally, variations of the Tukey technique pay a penalty at the level of simple comparisons. The Tukey - Overall technique requires a penalty for all possible pairwise comparisons; execution of these comparisons is contingent upon significance of the omnibus *F*. The Tukey - Row technique uses both the omnibus *F* and the analysis of simple effects as filters, then requires a penalty at the level of simple comparisons. The penalty, however, is paid only for the pairwise comparisons within each significant simple effect.

The key question in Study 1 is whether all of these techniques sufficiently control the compounding of familywise Type I error. If a technique produces an empirical value for α_{FW} which is greater than .05, that technique does not offer adequate protection and,thus, should not be used. In addition, some of the results of Study 1 are used to demonstrate the reliability of the Monte Carlo generation program.

Method

A Monte Carlo simulation computer program (presented in Appendix A) randomly generated data for 20,000 3 x 5 between subjects factorial experiments. Half of these experiments were conducted using a cell size of 8; the remaining experiments were conducted using a cell size of 15. The data were then submitted to a series of programs which conducted statistical analyses. Seven methods for controlling familywise Type I error were applied to the data in these programs. In addition, a technique analogous to planned comparisons (where the same comparisons are tested directly without the omnibus or simple

CHAPTER II

STUDY 1: TYPE I ERROR

Study 1 focused on Type I error in a 3 x 5 between subjects factorial design. Specifically, seven techniques for controlling the compounding of familywise Type I error were compared. These seven techniques are briefly reviewed here for convenience; detailed descriptions of each technique are presented in Chapter I.

The techniques under investigation vary in the method used to control the compounding of Type I error. For example, the Fisher technique and the Keppel technique both utilize a "filtering" approach; Fisher uses an omnibus *F* test while Keppel combines the omnibus *F* test with the analysis of simple effects. With both of these techniques, the analysis of simple comparisons is contingent upon significance at the higher level(s).

Rather than merely using a filtering approach, several other techniques require a penalty (in the form of adjusting α below .05) for conducting multiple comparisons. These techniques differ in both the severity of the penalty and where the penalty is paid. For example, variations of the Bonferroni technique pay a penalty by adjusting α at the level of simple effects. Three variations of the Bonferroni are examined in the present study: Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both. The Bonferroni technique pays the most severe penalty, followed by the Modified Bonferroni - Both technique then the Modified

Table 3. The combination of the effect size of the main effect and effect size of the interaction.

Condition	Main Effect	Interaction Effect
1	Null	Moderate
2	Null	Large
3	Null	Very Large
4	Small	Moderate
5	Small	Large
6	Small	Very Large
7	Moderate	Moderate
8	Moderate	Large
9	Moderate	Very Large

Null effect size $f = .00$

Small effect size $f = .10$

Moderate effect size $f = .25$

Large effect size $f = .40$

Very Large effect size $f = .60$

experiments.

Table 2. A comparison of differences in α_{PC} for the techniques examined by Reising (1993) and the present studies.

Reising (1993).

Post-hoc Analysis Procedure	Omnibus *F* Test of A x B Interaction	Analysis of Simple Effects	Analysis of Simple Comparisons
Keppel - No Penalty (KEP)	.05	.05	.05
Bonferroni (BON)	.05	.05/3 = .017	.05
Modified Bonferroni (MB)	.05	.10/3 = .033	.05
Modified Bonferroni - Both (MBB)	.05	.15/6 = .025	.05
Tukey - Row (TRow)	.05	.05	.01926

The Present Study.

Post-hoc Analysis Procedure	Omnibus *F* Test of A x B Interaction	Analysis of Simple Effects	Analysis of Simple Comparisons
Planned Comparisons (PLAN)	-	-	**.05**
Fisher LSD (FISH)	**.05**	-	**.05**
Keppel - No Penalty (KEP)	.05	.05	.05
Bonferroni (BON)	.05	**.05/5 = .010**	.05
Modified Bonferroni (MB)	.05	**.10/5 = .020**	.05
Modified Bonferroni - Both (MBB)	.05	**.15/10 = .015**	.05
Tukey - Overall (TOvl)	**.05**	-	**.00072**
Tukey - Row (TRow)	.05	.05	**.01896**

procedure typically adopted (i.e., omnibus test followed by analysis of simple effects followed by analysis of simple comparisons where each stage is contingent upon significance at a higher stage). In addition, the techniques examined by Reising (1993) will change in terms of α_{PC} . These differences are presented in Table 2. Finally, for comparison purposes, a technique of uncorrected pairwise simple comparisons will be presented. This technique is comparable to a planned comparison approach in that neither the omnibus F test nor analysis of simple effects is conducted.

Two Monte Carlo simulation studies were conducted, the first addressing Type I error, the second addressing Type II error and power. In Study 1, a computer program was used to randomly generate data for 2 sets of 10,000 3 x 5 between-subjects factorial experiments. The first set of data has a cell size of n = 8 and the second set has a cell size of n = 15. Therefore, the only independent variable manipulated in Study 1 is sample size[5].

In Study 2, data was generated by a computer program to match different effect sizes of the main effects and the interaction effects. Four independent variables were manipulated: sample size (n = 8, n = 15 as described above), effect size of the main effect (see Table 3), effect size of the interaction (see Table 3), and pattern of results (minimum variability, maximum variability). This combination of results in a 2 x 3 x 3 x 2 factorial design. For each of the 36 resulting conditions, data was generated for 10,000 3 x 5 between subjects factorial

[5]Sample sizes of 8 and 15 were selected to maintain consistancy between the current studies and those conducted by Reising (1993). These sample sizes were arbitrarally selected by Reising because they were thought to be representative of those found in typical psychological research.

In addition, the present study of Type II error uses interaction effect sizes of .25, .40, and .60, rather than the .10, .25, and .40 used by Reising (1993). There are two major reasons for using these alternative effect sizes. First, in Reising's study, with small effect sizes, the results showed little variability among techniques for controlling compounding familywise error. However, a general trend showed that as the interaction effect size increased, differences in the likelihood of Type II error increased. Second, with larger effect sizes, the intermediate simple effects filter will, theoretically, have less influence under the assumption that simple effect effect sizes are the same as the overall effect size. Consequently, in the present studies, more simple comparisons can be examined and a more complete representation of true differences among the control techniques can be obtained. Therefore, the relative difference among techniques may change. In addition, with effect sizes of .25, .40, and .60, the results of the present studies will be more comparable to those of Petrinovich and Hardyck (1969), who used similar effects sizes for one-way analyses of variance.

Finally, rather than simply comparing the same five techniques for controlling familywise error, two additional techniques are added (all seven techniques are described in the section above). This will extend the range of possible findings so that more comprehensive guidelines may be established for researchers in regard to the most appropriate method for controlling Type I error without a considerable loss of statistical power. The two techniques new to this study (*Tukey-penalty for all possible pairwise comparisons* and *Fisher least significant difference*) are unique in that both bypass the analysis at the level of simple effects. This will allow for examination of the efficacy of the filtering

important to bear in mind that only in roughly 13% of the cases investigated did the techniques differ in Type II error by more than 5%. Even when small interaction effect sizes are removed, only 19% of the remaining cases differ in Type II error by more than 5%. This was primarily due to the fact that the combination of sample sizes and effect sizes used resulted in relatively low power. It is evident that further studies should be conducted in order to precisely define the region of differences among post-hoc analysis techniques.

The Current Studies

This paper presents the results of two studies which parallel and extend those performed by Reising (1993). The critical differences between the prior research and that presented here are in the design used, the choice of effect sizes for study, and the techniques used to control compounding familywise error. The primary goals of the present studies are to 1) determine whether or not compounding familywise error remains under control (e.g., .05 or less) for seven popular post-hoc comparison techniques and 2) determine if there are differences in relative power among these techniques (and, if so, determine where they occur).

Specifically, the present studies employ a 3 x 5 factorial design, whereas Reising (1993) used a 3 x 3 design. The addition of levels is not as trivial as it may seem. By increasing the number of levels of an independent variable, the number of potential simple effects as well as simple comparisons analyses to be performed is increased. This increase will, in turn, affect the familywise error rate (as discussed above).

until the simple effect effect size was greater than .35 and the simple comparison effect size was greater than .30 (both the simple effect effect size and the simple comparison effect size are determined by the effect sizes for the main effect and the interaction effect). With small interaction effect size, there were no differences among the five techniques under investigation. With moderate interaction effect size, there were typically no differences among techniques for small sample size. On the other hand, with moderate interaction effect size *and* large sample size as well as with large interaction effect size (regardless of sample size), some differences among the techniques emerged. In general, the Keppel technique resulted in the lowest probability of committing a Type II error, followed by the Modified Bonferroni technique, the Modified Bonferroni-Both technique, and the Bonferroni technique, respectively. The Type II error rate for the Tukey technique varied with different effect sizes for the simple comparison within a given effect size for the simple effect, but generally proved to among the lowest probabilities of committing a Type II error.

It is interesting to note, however, that these differences among techniques emerged only when the effect sizes of the simple effects and the simple comparisons were relatively moderate. When the effect sizes of the simple effects and simple comparisons where relatively small, none of the techniques had sufficient power to detect true differences among means. When the effect sizes of the simple effects and the simple comparisons were large, all of the techniques were able to distinguish true differences between means, regardless of their relative power.

Although Reising noted times when the techniques differed, it is

Results From Reising (1993)

Reising (1993) conducted two Monte Carlo simulation studies which examined five different post-hoc multiple comparison techniques and their effects on Type I and Type II error rates in a 3 x 3 between-subjects factorial design. The first of his studies examined Type I error rates. Several trends were found. At both the levels of analysis of simple effects and analysis of simple comparisons, very little difference was found among techniques in terms of probability of committing a Type I error (the maximum difference between the lowest and highest probability of Type I error was .0087 for the analysis of simple effects and .0041 for the analysis of simple comparisons.

More importantly, upon examining the likelihood of committing at least one Type I error in a family of simple comparisons (familywise Type I error), differences among techniques were found to be rather small (the maximum difference between the lowest and highest probability of at least one Type I error within a family was .0192). Of those tested, none of the techniques had an α_{FW} which exceeded .05. The order of the techniques from lowest to highest α_{FW} was predictable: Bonferroni, Modified Bonferroni-Both, Tukey, Modified Bonferroni, Keppel - No penalty. Furthermore, the least stringent technique examined in this study (Keppel - No penalty) maintained an α_{FW} =.0437. Thus, all five of the techniques were effective in controlling α_{FW}.

The second of the studies by Reising (1993) examined Type II error. Under a simplifying assumption that a difference in Type II error of up to 5% among techniques was acceptable, Reising found that differences did not emerge

Tukey-penalty for a row. Using this variation on the Tukey test, control over compounding familywise error is partially exerted by conducting analysis of simple effects using α = .05. Following significance at the level of simple effects, simple comparisons are made using an adjusted critical value (F_{TRow}). The tests at the simple comparison level all make a correction for all pairwise comparisons for a given row (e.g., simple effect) rather than all possible pairwise comparisons. Here, a family is defined by a row, rather than by all possible pairwise comparisons of the data.

Again, in returning to the example of a 3 x 3 design,the adjusted critical value F_{TRow} can be computed. Using this version of the Tukey test, only 3 means would be examined per family, therefore, k = 3. Assuming a sample size of 8 and α_{FW} =.05, the critical value for the Studentized Range Statistic, q_t (3,63), is approximately 3.398. Therefore, the adjusted critical value for each simple comparison is computed as follows:

$$F_{TRow} = \frac{(3.398)^2}{2}$$
$$= 5.77$$

Here, α_{PC} is .01926. It is clear that this critical value results in a more stringent test of significance than would an uncorrected test (where F_{crit} = 4.00). However, the penalty paid at the level of simple comparisons using this version of the Tukey test is not as great as that paid by Tukey overall (bear in mind the fact that this version employs a filter at the level of simple effects).

appropriate tabled value for F, which leads to a more stringent test of significance, decreasing the probability of making a Type I error. Specifics of the variations of the Tukey test to be used in the present studies are given below, but in general, the techniques discussed below differ in two respects. First, the two techniques differ in whether or not simple effects are tested for significance. Second, these techniques differ in the degree of penalty paid at the level of simple comparisons which is governed primarily by k in determining q_t .

Tukey-penalty for all possible pairwise comparisons. Using this variation, all possible pairwise comparisons among means are tested for significance at the level of simple comparisons. The analysis of simple effects is bypassed, yet the researcher pays the penalty for all possible pairwise comparisons at the level of simple comparisons by using the formula above to compute the adjusted critical value (F_{TOvl}).

Returning to the example of a 3 x 3 factorial experiment, F_{TOvl} can be computed. Given such a design, there would be 9 means to be compared (k = 9). Assuming a sample size of 8 and α_{FW} =.05, the critical value for the Studentized Range Statistic, q_t (9,63), is approximately 4.55. Therefore, the adjusted critical value for each simple comparison is compute as follows:

$$F_{TOvl} = \frac{(4.55)^2}{2}$$
$$= 10.35$$

In this case, the α_{PC} is .00205. The comparable uncorrected critical value of F is approximately 4.00[4]. As can be seen, the Tukey test is more stringent and, therefore, reduces the likelihood of a Type I error.

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[4] *F(1,63)* with α = .05.

Controlling familywise error at the simple comparisons level.

Researchers may also choose to control for familywise error by corrections at the level of the analysis of simple comparisons. Several techniques have been developed for correcting at this level, including the Scheffé test (Scheffé, 1953) and the Tukey test (Winer, 1972). Some researchers have criticized the Scheffé test for being overly conservative (Carmer & Swanson, 1973; Keppel, 1991; Petrinovich & Hardyck, 1969), so the current research will focus primarily on variations of the Tukey test as the methods for controlling for compounding familywise error at the level of simple comparisons.

In general, when performing any variation of the Tukey test, α_{FW} is set at .05 and a correction is made based on the number of simple comparisons to be conducted. Analysis of simple comparisons using this corrected α_{FW} follows a significant simple effect assessed at the .05 level. A critical value for Tukey (F_t) is computed using the formula

$$F_t = \frac{(q_t)^2}{2}$$

where

q_t = tabled value of the studentized range statistic with the following parameters: the number of means to be compared (k), degrees of freedom for error (defined as k (n - 1)), and α_{FW}.

The obtained value of F is compared to the adjusted critical value, F_t, in order to determine significance. This adjusted critical value is greater than the

c is the number of simple effects to be conducted.

Modified Bonferroni-Both. Kirk (1982) discusses yet another approach to defining the acceptable level for α_{FW} in the analysis of simple effects. He holds that it is possible to examine simple effects from both perspectives (both A@B_j and B@A_j). Returning to the example of a 3 x 3 design, it can be seen that a total of six simple effects may be conducted. However, now the analysis cuts across three families rather than just two (the main effect of A, the main effect of B, and the interaction effect of A x B). Again in order to arrive at α_{FW} for the simple effects, the α_{FW} for each of these families is summed, yielding the adjusted value of α_{MB-B},

$$\alpha_{MB-B} = \alpha_{FW}/c$$

where

α_{MB-B} is the adjusted per comparison α.

α_{FW} is the acceptable familywise error rate. With the Modified Bonferroni-Both technique, α_{FW} is set at .15 because the interaction and both of the main effects are assumed to be families.

c is the number of simple effects to be conducted, which is now increased because the researcher will examine the interaction from both perspectives.

Despite the fact that each of these techniques assess the correction at the level of analysis of simple effects, it can be seen that they lead to different degrees of error rate penalty depending upon how a family is defined.

$$\alpha_B = {\alpha_{FW}}/{c}$$

where,

α_B is the adjusted per comparison α.

α_{FW} is the acceptable familywise error rate. With the Bonferroni technique, α_{FW} is set at .05 because the interaction is assumed to be the only family.

c is the number of simple effects to be conducted.

Modified Bonferroni. Another approach is discussed by Kirk (1982). He argues that a simple effect cuts across two families, the main effect and the interaction effect (for example, if A@B_j is examined, it contains both the main effect of A and the interaction effect of A x B). Kirk maintains that researchers must account for both of these effects when defining the familywise error rate by holding α = .05 for each of these families. Therefore, α_{FW} for the simple effect is defined as .10 (by summing α_{FW} for the main effect of A and the interaction effect of A x B). To compute the adjusted α, (α_{MB}),

$$\alpha_{MB} = {\alpha_{FW}}/{c}$$

where

α_{MB} is the adjusted per comparison α.

α_{FW} is the acceptable familywise error rate. With the Modified Bonferroni technique, α_{FW} is set at .10 because both the interaction and the main effect of interest (e.g., the main effect of A) are assumed to be families.

simple effect. This technique is similar to the logic proposed by Fisher (1951) in which it is maintained that statistical tests at a higher level exert enough control over compounding error. However, the Keppel technique employs two filters - the omnibus F test and the analysis of simple effects, whereas the Fisher technique uses only one filter - the omnibus F test. Keppel argues that this "filtering technique" exerts control by limiting the number of tests to be performed. Furthermore, Keppel contends that this technique effectively controls Type I error without causing a loss in power.

Controlling familywise error at the simple effects level.

Others (cf., Keppel, 1991; Kirk, 1982) discuss a technique for controlling familywise error which involves a correction during the analysis of simple effects. An adjusted α value is computed by dividing the acceptable familywise error by the number of simple effects to be tested. This adjusted α is then used as the significance level in the analysis of simple effects. Any simple effect which is significant at this adjusted α is then followed by simple comparisons which are assessed for significance at the .05 level. There is, however, some debate as to what constitutes an acceptable error rate for a family of tests. In general there are three approaches to adjusting the overall acceptable error rate. These three techniques are described below.

Bonferroni. The first approach is to set α_{FW} to .05 because the interaction represents one family of statistical tests. This is the approach described by Keppel because researchers typically examine simple effects from only one perspective (either $A@B_j$ or $B@A_j$). To compute the adjusted α (α_B),

significant omnibus F is followed by unrestricted comparisons among means; this technique is, therefore, nothing more than a protected t-test. The logic behind this technique holds that the omnibus F test, alone, is sufficient to control for Type I error. This same logic may be applied to factorial designs. If the omnibus F for the interaction is non-significant, no further analysis is performed. If, however, a significant omnibus F is obtained for the interaction, then unrestricted comparisons of individual cell means follows. The analysis of simple effects would not be conducted. Although not identified as such in the literature, this technique of controlling compounding familywise Type I error in a factorial design will be referred to as the Fisher technique.

The Fisher LSD test has been hailed by some researchers (Cohen & Cohen, 1983; Carmer & Swanson, 1973) as a solid alternative which offers an attractive balance between controlling Type I error and power. However, others (Hayter, 1986; Keslman, Games, & Rogan, 1980; Ramsey, 1981; Ryan, 1980) recommend against using the Fisher test due to its lack of control over compounding familywise error. The Fisher test has been found particularly problematic when unequal variances are paired with unequal n (Keppel, 1982; Zwick & Marascuillo, 1984).

Keppel-no penalty. Keppel (1991) discusses a technique in which no correction is made to control for compounding familywise error; all simple effects and simple comparisons analyses are conducted at the .05 significance level. However, each level of analysis is contingent upon significance at a higher level. Therefore, analysis of simple effects only follows a significant omnibus F for the interaction and analysis of simple comparisons only follows a significant

Table 1. Summary of post-hoc analysis techniques.
Values represent α for each comparison made at the levels specified.

Post-hoc Analysis Procedure	Omnibus *F* Test of A x B Interaction	Analysis of Simple Effects	Analysis of Simple Comparisons
<u>No Penalty</u>			
Fisher LSD (FISH)	.05	-	.05
Keppel - No Penalty (KEP)	.05	.05	.05
<u>Penalty at Simple Effects</u>			
Bonferroni (BON)	.05	.05/3 = .017†	.05
Modified Bonferroni (MB)	.05	.10/3 = 033†	.05
Modified Bonferroni - Both (MBB)	.05	.15/6 = .025†	.05
<u>Penalty at Simple Comparisons</u>			
Tukey - Overall (TOvl)	.05	-	.00205†
Tukey - Row (TRow)	.05	.05	.01926†

† assuming a 3 x 3 design.

<u>Paying no penalty</u>.

Two of the techniques which researchers have available for controlling the compounding of familywise Type I error involve paying no specific penalty for the number of tests which are to be conducted. In both of these techniques, given a significant omnibus F for the interaction, further statistical tests are conducted. The two techniques presented in this section differ only in the fact that one tests simple effects for significance while the other does not.

Fisher least significant difference test. The Fisher least significant difference (LSD) test is one technique available to researchers. Fisher (1951) originally proposed the Fisher test for one-way designs. With the Fisher technique, a

among means and a moderate interaction effect:

	A1	A2	A3	Σ
B1	- 0.30619	0	0.30619	0
B2	0	0.30619	- 0.30619	0
B3	0.30619	- 0.30619	0	0
Σ	0	0	0	0

Again, the value of *d* used to produce this matrix was .61237 (see page 14 for details on its computation). In examining this matrix, it can be verified that the constraints discussed above are met. The interaction matrix presented above assumes a null main effect. To produce an interaction matrix where the main effect is not zero, the effect coefficients from the appropriate main effect matrix are added to the effect coefficients in each row of the interaction matrix.

Controlling Familywise Error Rate

Several techniques for control compounding familywise error are available. Because it is impossible to sample each of these, the present studies will focus on seven of the more commonly used techniques. In general, these techniques fall into three classes. Researchers may choose to pay no penalty, to make a correction at the level of the simple effects, or to make a correction at the level of simple comparisons. The techniques used in this study are explained further in this section. For a summary of these techniques, readers are directed to Table 1.

$$d = .25\sqrt{2(3)}$$
$$= .61237$$ [3]

For any given pattern of variability, *d* must be converted to represent treatment means. In order to do this, the following constraints must be met: 1) the effects for any given row or column must sum to zero (according to the fixed effects model); 2) the sum of the squared effects divided by k equals *f* squared; and 3) the maximum difference between the smallest and largest means across levels is equal to *d*.

Returning to the example of a 3 x 3 factorial experiment presented above, to generate data with minimum variability among means where the main effect of A is moderate (as defined by a value of $f = .25$), the following matrix is added to randomly generated data:

A1	A2	A3
- 0.30619	0	0.30619

The value of *d* used to produce this matrix was .61237 (see page 14 for details on its computation). In examining this matrix, it can be verified that the constraints discussed above are met.

To generate a matrix for an A x B interaction effect, effect coefficients for the first row (simple effect) are produced in a manner identical to that used to produce main effects. These coefficients are then rotated across the levels of A. The resulting matrix is for a 3 x 3 factorial experiment with minimum variability

[3]Note that k = 3 in this example, not 9. Here, k is equal to the number of cells per row, in which this effect will be distributed.

midpoint.

2. *intermediate variability*: The means are equally spaced over the range.

3. *maximum variability*: Half of the means fall at each extreme.

The formula for the *d* statistic depends upon the pattern of variability.

1. *minimum variability*:

$$d = f\sqrt{2k}$$

2. *intermediate variability*:

$$d = 2f\sqrt{\frac{3(k-1)}{k+1}}$$

3. *maximum variability*:

$$d = 2f \text{ (when k is even)}$$

$$d = f\frac{2k}{\sqrt{k^2-1}} \text{ (when k is odd)}$$

In the current study, when Type II error is simulated, *d* can be computed using the formulae above given the effect size and k. The *d* statistic gives the difference between the largest and smallest treatment means. For example, in a 3 x 3 factorial design with a moderate effect ($f = .25$) where there is minimum variability among treatment means, *d* could be computed using the following formula:

$$d = f\sqrt{2k}$$

Furthermore, since data are generated such that the population mean is 0, the formula for the effect size index is simplified to

$$f = \sqrt{\frac{\sum (\mu_i)^2}{k}}$$

In this simplified form, it can easily be seen that as the difference among means increases, so too does the effect size coefficient. Cohen argues that in behavioral and social science research, small, medium, and large effect sizes are those with effect size coefficients of .10, .25, and .40, respectively.

A central aspect of Cohen's effect size index is the standardized range of the population, also known as the *d* statistic. *d* is defined by the following formula:

$$d = \frac{\mu_{max} - \mu_{min}}{\sigma}$$

where

μ_{max} is the largest of the k means

μ_{min} is the smallest of the k means

When $\sigma = 1$ in randomly generated data, *d* can be reduced to:

$$d = \mu_{max} - \mu_{min}$$

which specifies the maximum difference among means.

The *d* statistic is a measure of dispersion among treatment means. Cohen specifies three such patterns which a researcher might find:

1. *minimum variability*: One mean is at each extreme and the others are at the

be generated with the appropriate effect sizes for A, B, and A x B, which should produce significant results. Any failure to find significance represents Type II error.

Cohen (1988) provides a method of generating effect sizes of different magnitude. This method involves varying the likelihood of a Type II error by changing the treatment magnitude while holding error variance constant. The f index (effect size index) represents the strength of the relationship between the independent and dependent variable. The following formulae are use to compute the f index:

$$f = \frac{\sigma_\mu}{\sigma}$$

and

$$\sigma_\mu = \sqrt{\frac{\sum (\mu_i - \mu)^2}{k}}$$

where:

μ_i is the mean for a given group in the population,

μ is the population mean,

k is the number of means, and

σ is the population standard deviation.

The ratio of the treatment magnitude (represented by $\sigma\mu$) to the error variance (represented by σ) results in f. Because data are randomly generated with a mean of 0 and a standard deviation of 1, the formula for the f index can be reduced to :

$$f = \sigma_\mu$$

understanding of Monte Carlo techniques. The linear additive model illustrates that any score, X, can be produced by the formula:

$$X = \mu + \alpha_i + \beta_j + \alpha_i\beta_j + E\sigma/ij\ \alpha_i$$

where:

μ is the population mean (which is constant across all scores),

α_i is the effect of treatment i (the main effect of variable A),

β_j is the effect of treatment j (the main effect of variable B),

$\alpha_i\beta_j$ is the effect of the interaction (factorial combination of A x B), and

$E\sigma/ij$ is experimental error, which is random, normally distributed with a mean = 0 and a variance typically set at 1.

Given this explanation, a Monte Carlo study randomly generates data to meet certain specifications. For example, if variable A is to have an effect, non-zero values are entered into the cells for the main effect of A. As a result of the fixed effects model, values are placed in the cells for a given effect such that the sum of these values is equal to zero. If no effect is desired for A, then zeros are entered in all of these cells.

To simulate Type I error, then, zeros are entered into all cells in the α_i, β_j, and $\alpha_i\beta_j$ matrices. Data are then randomly generated to yield a population whose mean is 0 and standard deviation is 1. Any significant effects found would be due to chance. Given that the significance level is set to .05, one would expect 5% of the tests to be significant due merely to chance.

To simulate treatment effects, on the other hand, effect sizes must be entered for any combination of the effects of A, B, and A x B. Data would then

of these studies simulated Type I error, therefore, no treatment effects were simulated. However, in the second study, treatment magnitude, as well as sample size, were manipulated as independent variables in order to examine Type II error. Error variance was not manipulated in either of the current studies.

Power is also affected by changing the significance level. The significance level can be thought of as the likelihood of committing a Type I error in any given statistical test (or family of statistical tests). By adopting a more stringent significance level, a researcher decreases the likelihood of attributing differences among treatment means to a manipulation when they were actually due to chance (a Type I error). In addition, however, the researcher also decreases the likelihood of detecting effects which were due to the manipulation (power). The relationship between Type I error and power may be more clearly understood by examining Figure 3. By selecting a more stringent significance level (as depicted in Figure 3B), the researcher decreases the likelihood of making a Type I error. However, the probability of missing true treatment effects (a Type II error) is increased. Given that power = 1 - β, as β increases, the power to detect true effects is decreased. In terms of complex factorial designs, reducing the likelihood of a Type I error by controlling α_{FW} may decrease the sensitivity of the experiment. The key, then, is to balance Type I and Type II error to achieve a reasonable level of power, which is of primary concern in this study.

Monte Carlo Simulation of Type I and Type II Errors

An understanding of the general linear additive model is necessary to the

3) error variance. The effects of these factors can be readily seen by examining the formula for power and the associated statistic, ϕ. The aforementioned factors are represented in the following formula:

$$\phi = \sqrt{n \frac{\sum (\mu_i - \mu_t)^2 / a}{\sigma s^2 / a}}$$

where:

n is the sample size,

μ_i are the population treatment means,

μ_t is the mean of treatment means,

a is the number of treatment means, and

$\sigma s^2/a$ is the mean variance in the treatment populations.

In this equation, the numerator represents the treatment magnitude. As this value increases, so does the value of ϕ. This indicates that as treatment magnitude increases, power increases and the likelihood of a Type II error decreases. In the above equation, n represents sample size. Again, as n increases, so does the value of ϕ, indicating, once again, that as sample size increases, power increases and the likelihood of a Type II error decreases. Finally, the denominator represents error variance. As this value increases, the value of ϕ decreases. This indicates that as error variance increases, power decreases and the likelihood of a Type II error increases.

Treatment magnitude, sample size and error variance all have an effect on power, as well as Type II error. For this reason, sample size was manipulated as an independent variable in both of the studies presented in this paper. The first

greater than the acceptable .05 level. In a 3 x 4 or 3 x 5 factorial experiment, these values would be even greater, yet ($1-(.95)^{12}$ and $1-(.95)^{15}$, respectively).

In order to control for this problem of compounding familywise error, the researchers typically adopt a more stringent significance level for each statistical test conducted. Frequently, researchers choose to use the Bonferroni technique, defined by the formula:

$$\alpha_{PC} = \alpha_{FW}/c$$

where:

α_{PC} is the adjusted probability of making a Type I error for each test.

The Bonferroni technique holds α_{FW} constant (typically at .05) and adjusts the significance level for each test. In the example,

$$\alpha_{PC} = .05/9$$

$$= .0056.$$

Therefore, each statistical test should be performed at the .0056 level to preserve α_{FW} at .05. However, by adopting a more stringent significance level, the researcher is faced with an increase in Type II error. Along with an increase in Type II error comes a loss in power. The following section discusses the concept of statistical power as well as factors which directly affect power.

Factors Affecting Type II Error and Power

There are three primary factors which have an effect on Type II error and, in turn, power: 1) the magnitude of the treatment effect, 2) the sample size, and

When conducting a large number of statistical tests (as is the case in post-hoc analysis strategies), the chance of committing at least one Type I error increases as the number of tests increases. In the example of the 3 x 3 factorial experiment presented above, if the interaction effect was significant in the omnibus *F* test, it would be followed by three simple effects test (A @ B1, A @ B2, and A @ B3). If, in turn, all three of these tests were significant, three simple comparisons would be conducted at each level of B, resulting in 9 tests at this level. Assuming each of these nine test are conducted at the .05 level, the probability of making at least one Type I error in this family (α_{FW}) can be computed using the following formula[2]:

$$\alpha\text{FW} = 1 - (1 - \alpha)^c$$

where:

c = the number of statistical tests.

In the example,

$$\alpha\text{FW} = 1 - (1 - .05)^9$$
$$= .3698$$

This may be approximated using the formula:

$$\alpha\text{FW} \approx \alpha(c)$$

Again, in the example,

$$\alpha\text{FW} \approx .05(9)$$
$$\approx .4500$$

Regardless of which value is used, it is clear that this probability is much

[2]This formula is appropriate when comparisons are orthogonal.

responsible for the differences. Power is defined as 1 - β, therefore as Type II error (β) increases, power decreases and vice versa.

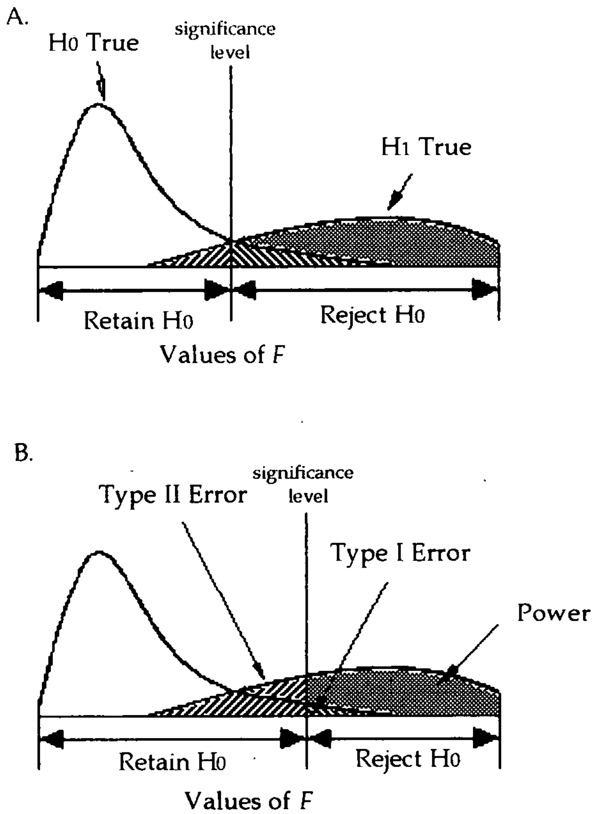

Figure 3. The relationship among Type I error, Type II error, and power (adapted from Keppel, 1991).

The Problem of Compounding Type I Error

Type I error is affected by the significance level adopted by the researcher. If a .05 significance level is adopted, then 5% of the time a Type I error will occur. To control Type I error, a more stringent significance level may be adopted (usually, α =.01). By doing so, however, the researcher increases the number of Type II errors. This relationship is represented in Figure 3.

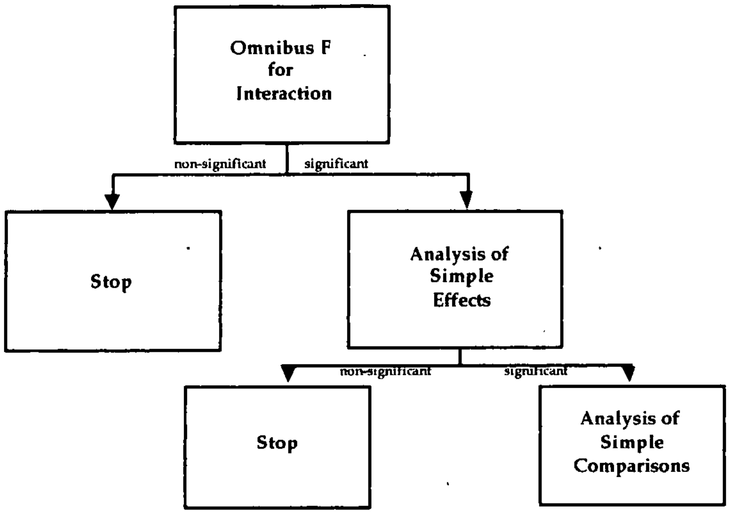

Figure 2. Steps in the contingency analysis process.

Type I Error, Type II Error and Power

When an effect is tested for significance, the researcher concludes whether or not these results are due to sampling error or a true treatment effect. In analysis of variance, to determine significance, an obtained F value is compared to a critical value for F. There are two potential types of errors which may occur: Type I (α) and Type II (β). A Type I error occurs when the results are inappropriately attributed to a treatment effect when sampling error is responsible. A Type II error, on the other hand, occurs when the results are attributed to sampling error when there is really a treatment effect.

A concept related to Type II error is power. Power is a statistical concept defined as the probability of finding a statistically significant treatment effect when treatment is truly responsible for the effect, or in other words, it is the sensitivity of the experiment to get a significant result when the treatment is

example, the following simple comparisons would be conducted: A1 vs. A2 @ B1, A1 vs. A3 @ B1, and A2 vs. A3 @ B1. This example assumes that only pairwise comparisons will be performed (a reasonable assumption since many researchers conduct only pairwise comparisons because of their ease of interpretation).

To summarize the entire procedure of post-hoc analyses of interactions, an omnibus *F* test is performed to reveal whether there are any differences among the groups tested. If the omnibus *F* test is significant, then it is followed by an analysis of simple effects. The analysis of simple effects is used to discover any differences among levels of a given independent variable at each level of the other independent variables. For each simple effect that is significant, analysis proceeds to the final step, the analysis of simple comparisons. Analysis of simple comparisons compares each level of an independent variable with every other level at the a given level of the other independent variable. This entire process is depicted graphically in Figure 2.

In the first stage of the post-hoc analysis procedure, the main effects (A and B) and the interaction effect (A x B) are tested for significance. If the interaction effect is significant, researchers know that the effect of A is different across levels of B, or vice versa (depending upon the perspective taken by the researcher). However, exactly where these differences are is still unknown. Traditionally, to determine which groups are different, researchers must proceed to a second stage, the analysis of simple effects (Rosnow & Rosenthal, 1989). At this stage, the effects of one independent variable are determined at the various levels of another independent variable (i.e., A @ B1, A @ B2, A @ B3, or B @ A1, B @ A2, B @ A3). Within the simple effect, the treatment variance can be broken up into variance in the main effect and variance in the interaction effect (Kirk, 1982). This can be seen in the Sum of Squares formula of the simple effect A @ Bj ($SS_{A\,@\,Bj}$):

$$SS_{A@B_j} = \Sigma(SS_A + SS_{A \times B})$$

It is important to keep in mind that the main effect contributes to the variance of the simple effect, a concept which, according to Rosnow and Rosenthal (1989), many researchers do not understand.

Continuing with the example, suppose that one of the simple effects, A @ B1, was found to be significant. If this is the case, variable A is having an effect at B1, but the researcher is unsure which levels of A are different from one another. Therefore, the researcher must proceed to the third stage, the analysis of simple comparisons. At this stage, all of the treatment means are typically compared in a pairwise fashion. For example, given that A @ B1 was significant in the above

interaction effects.

The current paper presents two Monte Carlo simulation studies which extend the work of Reising (1993). The purpose of the present studies is to compare alternative methods for controlling familywise error and extend guidelines put forth by Reising (1993) on the appropriate technique for controlling familywise error.

Background

When dealing with analysis of variance, post-hoc analyses typically consist of 3 stages: 1) omnibus *F* test, 2) analysis of simple effects (contingent upon a significant omnibus *F* test), and 3) analysis of simple comparisons (contingent upon a significant simple effect). In the example which follows, a 3 x 3 between-subjects design[1], will be used. Figure 1 shows a graphical representation of this design. A 3 x 3 factorial contains main effects of both variables (A and B in the example), as well as an interaction effect (A x B).

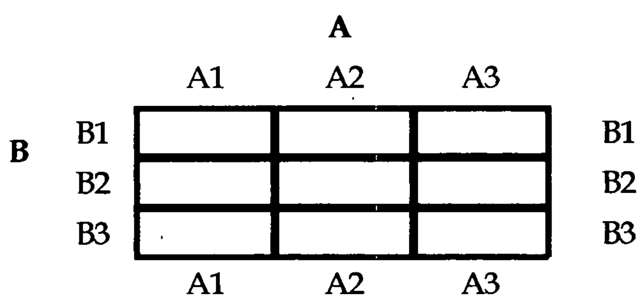

Figure 1. A representation of a 3 x 3 factorial design.

[1]Throughout this paper, a 3 x 3 between-subjects factorial design will be used for examples. This design is used for purposes of simplicity.

CHAPTER I

INTRODUCTION

Despite the fact that a vast amount of research exists on post-hoc analyses following analysis of variance (ANOVA), most of it has focused on one-way designs (i.e., Jaccard, Becker, & Wood, 1984; Keselman, Keselman, & Games, 1991). There is, however, a dearth in the literature dealing with post-hoc analyses dealing with factorial designs. Of particular concern is identifying *the* appropriate technique for controlling familywise error in post-hoc tests following a significant interaction. According to Keppel (1991),

> You are certainly on your own when the topic of familywise error is raised during the planning and analysis of a factorial experiment than was the case with the single-factor experiment. In either situation, you will have to set your own criteria and worry about the consequences stemming from your decision. But there has been considerably less discussion of the problem with the factorial design.Current practice in psychological research favors analysis without correction for FW rate. Certainly more discussion of the problem of FW error is needed so that researchers can see clearly the issue at stake and the long term consequences of alternative solutions to the problem (p. 248).

Reising (1993) examined the topic of compounding error rate in a factorial design. Although the results were fruitful in defining some rules of thumb to reduce error in post-hoc analyses for researchers, Reising's studies made it clear that additional work is necessary to identify what techniques are most appropriate for controlling compounding error rates in post-hoc analysis of

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Finally, I would like to thank my family (Mom, Dad, Nick and Candi) and friends who have supported me through all of my academic efforts. I hope to make them proud of my achievements.

from most to least was Bonferroni, Modified Bonferroni, and Modified Bonferroni - Both. Finally, two variations of the Tukey technique were examined in which a penalty is paid at the level of simple comparisons. The Tukey - Overall technique required a penalty for all possible pairwise comparisons and did not test any simple effects. The Tukey - Row technique uses both the omnibus *F* and the analysis of simple effects as filters, then requires a penalty at the level of simple comparisons within each significant simple effect.

Study 1 examined Type I error. The results show that all of the techniques with the exception of Fisher maintained familywise Type I error rates (α_{FW}) of less than .05. Study 2 examined the magnitude of differences in Type II error among the techniques in 36 conditions resulting from the factorial combination of sample size (n = 8, n = 15), effect size of a main effect ($f = .00, f = .10, f = .25$), interaction effect size ($f = .25, f = .40, f = .60$), and pattern of variability (minimum, maximum). The filtering techniques maintained lower Type II error rates than the penalty techniques. On average, there was more than a .05 difference in Type II error between the filtering techniques (Fisher and Keppel) and the penalty techniques in 54% of the comparisons tested. Although the Fisher technique had a lower Type II error rate than the Keppel technique, they differed by more than .05 in only 25% of the cases examined.

The results of both studies tend to support the use of the Keppel technique because it maintained $\alpha_{FW} < .05$ (unlike Fisher) while offering high statistical power (unlike the penalty techniques).

ABSTRACT

A COMPARISON OF METHODS FOR CONTROLLING FAMILYWISE ERROR: POST-HOC ANALYSES FOR FACTORIAL DESIGNS

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This paper presents the results of two Monte Carlo studies investigating seven post-hoc multiple comparison procedures in the analysis of the interaction in a 3 x 5 experimental design.

The techniques under investigation differed in the method used to control familywise Type I error. Two techniques utilize a "filtering" approach in which the analysis of simple comparisons was contingent upon significance of the omnibus *F* ("Fisher") or both the omnibus *F* and simple effects ("Keppel"). Other techniques which were investigated required a penalty (in the form of adjusting α below .05) for conducting multiple comparisons. These techniques differ in both the severity of the penalty and where the penalty is paid. Three variations of the Bonferroni technique were examined in which a penalty was instituted at the level of simple effects. The severity of the simple effects penalty