APPENDIX A

Raw Data from the Dual-Task Meta-Analysis in Alzheimer's Disease

Table A-1

Sample of Studies Including Task Types: Latency data

Study/Condition	WM Task	Age_{HO}	Age_{AD}	$MMSE_{AD}$	n_{HO}	n_{AD}	Single-task RT (ms) HO	Single-task RT (ms) AD	Dual-task RT (ms) HO	Dual-task RT (ms) AD
Baddeley et al. (1986, 1991)										
Cond. 1	YES	64	64.9	-	28	28	418.0	721.3	479.4	1041.9
Filoteo et al. (1992)										
Cond. 1	YES	71.8	72.14	-	15	14	842.57	1701.96	966.00	3296.18
Cond. 2	YES	71.8	72.14	-	15	14	751.87	1697.46	1004.2	2694.46
Nebes & Brady (1989)										
Cond. 1	YES	70.4	70.6	18.7	36	18	588	725	669	860
Cond. 2	YES	70.4	70.6	18.7	36	18	588	725	679	874
Cond. 3	YES	70.4	70.6	18.7	36	18	646	901	695	1041
Cond. 4	YES	70.4	70.6	18.7	36	18	646	901	763	1176
Nestor et al. (1991)										
Cond. 1	YES	66.5	66.4	23	9	10	314	359	474	543
Cond. 2	YES	66.5	66.4	23	9	10	658	798	647	862
Waters & Caplan(1997)										
Cond. 1	NO	71.6	71.5	21.93	12	17	302.1	549.5	244.6	454.0
Cond. 2	NO	71.6	71.5	21.93	12	17	372.5	605.1	188.3	630.5
Cond. 3	NO	71.6	71.5	21.93	12	17	442.5	871.7	315.8	641.3
Cond. 4	NO	71.6	71.5	21.93	12	17	277.0	436.4	187.9	575.5
Cond. 5	NO	71.6	71.5	21.93	12	17	247.7	421.8	126.5	529.9
Cond. 6	NO	71.6	71.5	21.93	12	17	395.5	948.8	235.5	881.7
Cond. 7	NO	71.6	71.5	21.93	12	17	302.1	549.5	254.3	506.9
Cond. 8	NO	71.6	71.5	21.93	12	17	372.5	605.1	251.8	501.1
Cond. 9	NO	71.6	71.5	21.93	12	17	442.5	871.7	360.2	808.5
Cond. 10	NO	71.6	71.5	21.93	12	17	277.0	436.4	165.5	521.8
Cond. 11	NO	71.6	71.5	21.93	12	17	247.7	421.8	145.7	409.8
Cond. 12	NO	71.6	71.5	21.93	12	17	395.5	948.8	371.1	970.8

Table A-1. Cond. = Condition. WM = absence or presence of a working memory task. HO = Healthy older adults. AD = Alzheimer's disease patients. RT = Reaction time.

Table A-2

Sample of Studies Including Task Types: Accuracy Data

Study/Condition	WM Task	Age_{HO}	Age_{AD}	$MMSE_{AD}$	n_{HO}	n_{AD}	Single-task % Correct HO	Single-task % Correct AD	Dual-task % Correct HO	Dual-task % Correct AD
Baddeley et al. (2001)										
Cond. 1	YES	74.36	76.28	19.94	36	36	98.8	94.2	98.0	88.2
Cond. 2	YES	74.36	76.28	19.94	36	36	100	93.0	98.0	77.7
Baddeley et al. (1986, 1991)										
Cond. 1	YES	64	64.9	-	28	28	54.3	59.8	53.3	51.7
Cond. 2	YES	64	64.9	-	28	28	54.3	59.8	52.4	54.0
Cond. 3	YES	64	64.9	-	28	28	54.3	59.8	48.4	42.2
Calderon et al. (2001)										
Cond. 1	YES	68.3	71.2	21.4	17	9	100*	82.4	84.5	59.4
Cond. 2	YES	68.3	71.2	21.4	17	9	60	70	50	60
Camicioli et al. (1997)										
Cond. 1	YES	72	74	21	23	15	100*	63.6*	78.3*	54.2*
Gainotti et al. (2001)										
Cond 1.	YES	69.3	67.8	19.1	40	68	98.4	80.0	59.8	57.3
Grady et al. (1989)										
Cond. 1	YES	63.7	63.6	-	33	32	90	66	60	41
Greene et al. (1995)										
Cond. 1 – Min. AD	YES	67.9	73.1	26.2	30	17	76	77	57	67
Cond. 1 – Mild AD	YES	67.9	66.2	20.3	30	16	76	65	57	51
Cond. 2 – Min. AD	YES	67.9	73.1	26.2	30	17	100*	93.3*	89.2*	64.2*
Cond. 2 – Mild AD	YES	67.9	66.2	20.3	30	16	100*	68.3*	89.2*	43.3*
Grober & Sliwinski (1991)										
Cond. 1	YES	82.3	83.0	-	26	26	98	89	91	81
Cond. 2	YES	82.3	83.0	-	26	26	97	79	89	66
Cond. 3	YES	82.3	83.0	-	26	26	92	71	74	53
Cond. 4	YES	82.3	83.0	-	26	26	99	97	97	92
Cond. 5	YES	82.3	83.0	-	26	26	100	94	98	87
Cond. 6	YES	82.3	83.0	-	26	26	97	89	92	74
Perry et al. (2000)										
Cond 1. –Min. AD	YES	67.8	68.2	26.08	44	13	100**	100**	99**	98**
Cond 1. –Mild AD	YES	67.8	70.1	20.4	44	14	100**	100**	99**	97**
Waters & Caplan(1997)										
Cond. 1	NO	71.6	71.5	21.93	17	17	95.9	93.4	95.5	89.6
Cond. 2	NO	71.6	71.5	21.93	17	17	92.9	88.0	91.2	87.9
Cond. 3	NO	71.6	71.5	21.93	17	17	96.6	80.9	92.6	80.4
Cond. 4	NO	71.6	71.5	21.93	17	17	99.5	96.1	97.6	87.7
Cond. 5	NO	71.6	71.5	21.93	17	17	99.0	94.2	97.6	82.8
Cond. 6	NO	71.6	71.5	21.93	17	17	95.6	87.7	91.5	69.3
Cond. 7	NO	71.6	71.5	21.93	17	17	95.9	93.4	98.5	89.6
Cond. 8	NO	71.6	71.5	21.93	17	17	92.9	88.0	92.2	86.7
Cond. 9	NO	71.6	71.5	21.93	17	17	96.6	80.9	94.6	81.9
Cond. 10	NO	71.6	71.5	21.93	17	17	99.5	96.1	99.0	86.8
Cond. 11	NO	71.6	71.5	21.93	17	17	99.0	94.2	98.5	84.8
Cond. 12	NO	71.6	71.5	21.93	17	17	95.6	87.7	89.2	63.2

Table A-2. Cond. = Condition. . WM = absence or presence of a working memory task. HO = Healthy older adults. AD= Alzheimer's disease patients.
*Mean accuracy of the older group set to 100%.
**Mean accuracy in single task set to 100%.

APPENDIX B

Table B-1

Reliabilities, Correlations and Stability for 1-Back and 2-Back

Platform	Seated		Stable Platform		Moving	
	1-Back	2-Back	1-Back	2-Back	1-Back	2-Back
Young Adults (N = 10)						
1-Back	+	+	*.10*	.63*	*.10*	.59*
2-Back		+		*.25*		*.35*
Stability	+	+	+	**.36**	**.15**	**.22**
Older Adults (N = 10)						
1-Back	*.77*	.32	*.74*	.33	*.80*	.73**
2-Back		*.45*		*.53*		*.47*
Stability	**.51**	**.80****	**.23**	**.89****	**.11**	**.88****
Older Low (N = 11)						
1-Back	*.69*	.36	*.68*	.33	*.71*	.86**
2-Back		*.56*		*.43*		*.51*
Stability	**.42**	**.73****	**.16**	**.68***	**.59**	**.66***
Alzheimer's (N = 9)						
1-Back	*.85*	.72**	*.93*	.56*	*.97*	.83**
2-Back		*.94*		*.63*		*.75*
Stability	**.72***	**.56***	**.86****	**.97****	**.54**	**.92****

Table B-1. *p < .05; ** p < .01. + denotes zero variance cells. Values in italics represent Cronbach`s α. **Bold** values represent stabilities. Reliabilities were computed within blocks in sessions 3 to 8. Within group correlations were computed between blocks in sessions 3 to 8. Stabilities were computed between session 3 and 8 for single task, between session 4 and 8 for stable, and 5 and 8 for moving platform conditions, respectively.

Table B-*2*

Reliabilities, Correlations and Stability for Balance Performance

	0-Back		1-Back		2-Back	
	Moving	Stable	Stable	Moving	Stable	Moving
Young Adults (N = 10)						
0-Back	*.92*	*.62*	.94**	.53	.91**	.54
1-Back			*.95*	*.88*	.88**	.74*
2-Back					*.92*	*.70*
Stability	**.12**	**.57***	**.15**	**.74***	**.93****	**.61**
Older Adults (N = 10)						
0-Back	*.94*	*.89*	.57	.88**	.92**	.82**
1-Back			*.51*	*.97*	.55	.63*
2-Back					*.83*	*.90*
Stability	**.46**	**.56***	**.63***	**.71****	**.86****	**.67***
Older Low (N = 11)						
0-Back	*.87*	*.85*	.64	.82**	.89**	.84**
1-Back			*.62*	*.91*	.62	.73*
2-Back					*.81*	*.88*
Stability	**.46**	**.56***	**.77****	**.68****	**.62****	**.69****
Alzheimer's (N = 9)						
0-Back	*.92*	*.93*	.66*	.92**	.67*	.93**
1-Back			*.73*	*.89*	.29	.89**
2-Back					*.83*	*.90*
Stability	**.55***	**.84****	**.84****	**.58**	**.90****	**.72***

Table B-2. *p < .05; ** p < .01. Values in italics represent Cronbach`s □. **Bold** values represent stabilities. Reliabilities were computed within blocks in sessions 4 to 8. Within group correlations were computed between blocks in sessions 4 to 8. Stabilities were computed between session 3 and 8 for single task, between session 4 and 8 for stable, and 5 and 8 for moving platform conditions, respectively.

Table B-3

Mean Performance in Cognition

	Seated	Stable PF	Moving PF	DTC Stable (%)	DTC Moving (%)
1-Back					
YA	100 (0.0)	100 (0.0)	99.8 (0.1)	0.0 (0.0)	0.1 (0.1)
OA	100 (0.0)	99.0 (0.7)	99.0 (1.1)	1.0 (0.8)	1.0 (0.9)
OAL	100 (0.0)	97.1 (0.3)	99.5 (0.3)	2.8 (1.6)	0.5 (0.3)
AD	86.2 (6.7)	83.7 (8.0)	80.5 (7.3)	3.1 (5.1)	6.1 (3.9)
2-Back					
YA	100 (0.0)	99.5 (0.3)	99.3 (0.4)	0.5 (0.3)	0.6 (0.4)
OA	95.7 (1.8)	87.3 (4.7)	83.6 (5.4)	9.2 (3.7)	13.1 (4.9)
OAL	91.1 (2.8)	85.2 (4.8)	79.2 (5.7)	6.9 (3.7)	13.9 (4.4)
AD	71.5 (9.3)	60.5 (9.1)	45.6 (6.5)	23.7 (6.7)	42.9 (4.4)

Table B-3. Data represent means ± standard errors. YO = Young Adults, OA = Older Adults, OAL = Older Adults low on Cognition, AD = Alzheimer's Patients. DTC = Dual-task Costs. PF = Platform.

Table B-4

Mean Performance in Balance

	0-Back	1-Back	2-Back	DTC 1-B(%)	DTC 2-B(%)
Stable PF					
YA	118.6 (12.9)	119.7 (16.6)	133.6 (25.6)	1.3 (4.5)	10.3 (5.8)
OA	127.5 (18.9)	142.3 (27.4)	168.6 (28.2)	13.5 (11.6)	39.6 (12.7)
OAL	80.9 (7.3)	81.1 (7.2)	106.7 (13.3)	7.6 (7.3)	35.4 (19.0)
AD	117.7 (13.4)	164.3 (24.1)	211.3 (31.7)	43.1 (14.7)	93.7 (26.7)
Moving PF					
YA	505.3 (34.6)	543.3 (21.3)	564.4 (48.1)	9.9 (4.5)	14.8 (6.8)
OA	725.9 (59.9)	765.4 (76.5)	881.4(101.5)	6.2 (4.8)	23.2 (9.6)
OAL	629.8 (40.1)	619.8 (35.4)	731.4 (65.0)	3.3 (4.9)	14.3 (6.5)
AD	1075.1(103.8)	1150.5(95.5)	1156.9(108.8)	9.1 (4.5)	9.6 (4.7)

Table B-4. Data represent means ± standard errors. YO = Young Adults, OA = Older Adults, OAL = Older Adults low on Cognition, AD = Alzheimer's Patients. DTC 1-B = Dual-task Costs with 1-Back, DTC 2-B = Dual-task Costs with 2-Back. PF = Platform.

APPENDIX C

Dual-Task Performance in 1-Back

In the following analyses, we included only those trials in which participants scored at least 4 correct in N-Back in order to ascertain that participants did actually perform the task rather than drop it completely in the dual-task context. The number of trials excluded for that reason differed between groups. While zero trials were below 4 correct in young adults, there were 13 trials (5.41%) in older adults, and 30 trials (13.88%) in Alzheimer's patients.

Figure C-1

Costs in 1-Back in Young and Older Adults, and Alzheimer's Patients

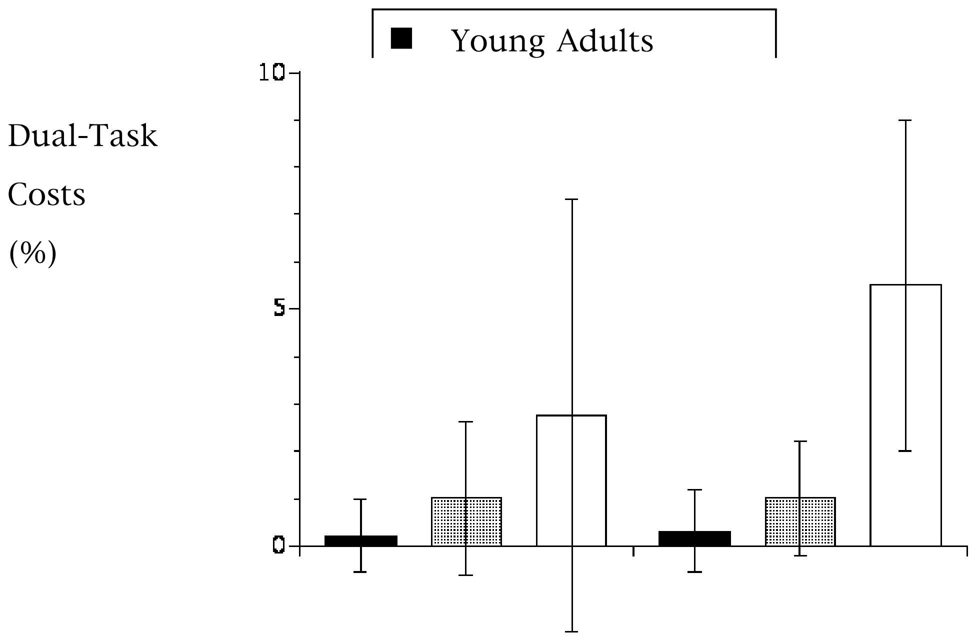

Figure C-1. Relative costs (%) in 1-Back, under stable and moving platform conditions, in young adults (depicted in black bars), older adults (gray bars), and Alzheimer's patients (white bars). Error bars reflect one standard error of the mean.

Dual-Task Costs in 1-Back

The costs in cognition for the 1-Back task on the stable and moving platform in young adults, older adults and Alzheimer's patients are depicted in Figure C-1.

Young versus older adults. To examine the change in 1-Back performance when adding a balance task at different levels of complexity between young and older adults, a 2 (group) x 3 (seated versus stable versus moving platform condition) x 2 (measurement occasion) ANOVA was performed. None of the effects or interactions turned out to be statistically reliable (all *ps* > .23), suggesting that performance in 1-Back was not affected by standing on a stable or a moving platform in both groups.

Older adults versus Alzheimer's patients. An analogous analysis was performed on 1-Back data comparing older adults and Alzheimer's patients. Performance in 1-Back was better in older adults than in Alzheimer's patients ($F(1,17) = 5.64$, $MSe = 73.18$, $p < .05$, $\eta^2 = .25$). However, none of the condition effects nor higher interactions turned out to be statistically reliable (all *ps* > .21), suggesting that standing on a stable or moving platform did not differentially affect performance in 1-Back.

Costs in Balance

Analogous analyses were performed for balance performance. The costs in balance on the stable and moving platform when adding the 1-Back task in young adults, older adults and Alzheimer's patients are depicted in Figure C-2.

Young versus older adults. To test for a differential decrease in balance performance when adding the 1-Back task between young and older adults under different complexity conditions, a 2 (group) x 2 (Baseline versus 1-Back) x 2 (stable versus moving platform condition) x 2 (measurement occasion) ANOVA was performed.

The data pattern violated homogeneity assumptions (Box's $M = 103.92$, $p < .05$). Performance in balance was better in young as compared to older adults ($F(1,18) = 9.21$, $MSe = 574841.10$, $p < .01$, $\eta^2 = .33$). A main effect for platform condition ($F(1,18) = 203.25$, $MSe = 9460134.9$, $p < .001$, $\eta^2 = .92$) emerged, which interacted with group ($F(1,18) = 9.26$, $MSe = 430881.85$, $p < .01$, $\eta^2 = .34$). None of the other effects was statistically significant (all *ps* > .10).

Figure C-2

Balance Costs for 1-Back in Young Adults, Older Adults, and Alzheimer's Patients

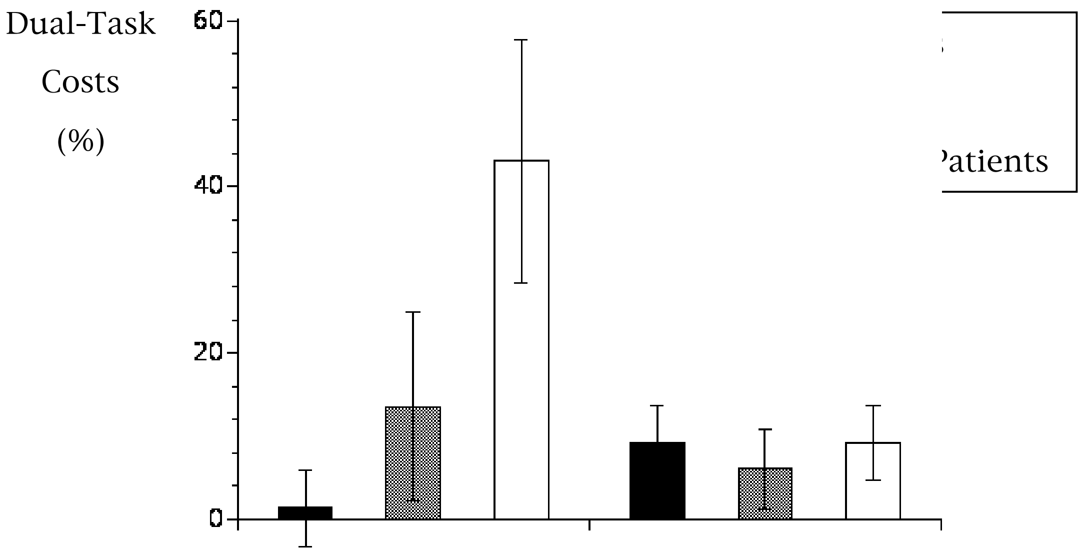

Figure C-2. Relative costs (%) in 2-Back, under stable and moving platform conditions, in young adults (depicted in black bars), older adults (gray bars), and Alzheimer's patients (white bars). Error bars reflect one standard error of the mean.

Post hoc tests showed that performance did not differ between baseline and 1-Back in any of the conditions (t-Tests; all *ps* > .17). Relative costs were computed. The 2 (group) x 2 (stable versus moving platform) data pattern of relative costs met homogeneity assumptions (Box's $M = 7.16$, $p = .10$). The ANOVA revealed no effects or higher interactions of statistical reliability (all *ps* > .26). Post hoc tests showed that in older adults, costs were only marginally different from zero on the moving platform ($t(9) = 2.22$, $p = .06$). In all other conditions, costs failed to emerge (t-Tests; all $ps > .23$).

Older adults versus Alzheimer's patients. Analogous analyses were performed between older adults and Alzheimer's patients.

The 2 (group) x 2 (Baseline versus 1-Back) x 2 (stable versus moving platform condition) x 2 (measurement occasion) data pattern met homogeneity assumptions (Box's $M = 63.77$, $p = .76$). Performance in balance was better in older adults as compared to Alzheimer's patients ($F(1,17) = 3.78$, $MSe = 959499.51$, $p < .05$, $\eta^2 = .24$). A main effect for platform condition ($F(1,17) = 220.39$, $MSe = 25592557$, $p < .001$, $\eta^2 = .93$) emerged, which interacted with group ($F(1,17) = 7.66$, $MSe = 889749.58$, $p < .05$, $\eta^2 = .31$). Furthermore, there was a main effect of N-Back condition ($F(1,17) = 9.85$, $MSe = 211628.30$, $p < .01$, $\eta^2 = .37$). Post hoc tests showed that, in older adults, performance did not differ between baseline and 1-Back in any of the conditions (t-Tests; all $ps > .17$). In Alzheimer's patients, too, only the difference between baseline and 1-Back on the stable platform was marginally significant ($t(8) = 2.09$, $p = .07$).

Relative costs were computed. The 2 (group) x 2 (stable versus moving platform) data pattern of relative costs met homogeneity assumptions (Box's $M = 0.55$, $p = .92$). The ANOVA revealed a significant effect of platform condition, indicating that costs were larger on the stable as compared to the moving platform ($F(1,17) = 4.71$, $MSe = 4045.60$, $p < .05$, $\eta^2 = .22$). Post hoc tests showed that in older adults, costs failed to emerge (t-Tests; all $ps > .23$), while in Alzheimer's patients, costs were significantly different from zero on the stable ($t(8) = 2.93$, $p < .05$) and on the moving platform ($t(8) = 2.46$, $p < .05$). The costs in Alzheimer's patients for 1-Back were larger on the stable as compared to the moving platform ($t(8) = 2.34$, $p < .05$).

In summary, significant costs emerged only in Alzheimer's patients. These costs were larger on the stable as compared to the moving platform, thus following the general pattern of prioritization predicted in the present study.

LEBENSLAUF

Michael Rapp, geboren am 18. April 1970 in Bardenberg/Aachen.

Schulischer und beruflicher Werdegang

1980-1985	Gymnasium Phillipinum, Marburg/Lahn
1985-1989	Konrad-Duden-Gymnasium, Wesel; 1989 Abitur
1990-1993	Studium der Humanmedizin an der Universität Würzburg; 1993 1. Staatsexamen
1993-1997	Studium der Humanmedizin und der Soziologie an der Freien und der Humboldt Universität Berlin; 1995 Vordiplom in Soziologie; 1997 Ärztliche Prüfung (3. Staatsexamen)
1997-1999	Tätigkeit als Arzt im Praktikum und Assistenzarzt am Klinikum Hellersdorf, Klinik für Gerontopsychiatrie, Berlin
1999-2002	Mitglied des Graduiertenkollegs "Psychiatrie und Psychologie des Alterns" an der Freien Universität Berlin; Doktorand am Max-Planck-Institut für Bildungsforschung, Berlin

Michael Rapp

Hiermit versichere ich, dass ich die hier vorliegende Dissertation auf der Grundlage der angegebenen Hilfsmittel eigenständig verfaßt habe. Die Dissertation war und ist nicht Gegenstand anderer akademischer Prüfungen.

Berlin, im Juni 2002

Michael Rapp