

# Computerised Cognitive Training in Healthy Older Adults A Systematic Review and Meta- Analysis of Effect Modifiers

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# Computerised Cognitive Training



# Cognitive Training in the Elderly

## State of the Field, 2015

- Hundreds of cognition-focused interventions have been proposed since the 1970s
- ~\$2b industry, dozens of startups
- Reviews tend to be inconclusive, lack focus
- As a consequence:
  - The 'brain training debate' carries on
  - Inconsistent study designs
  - Very slow translation



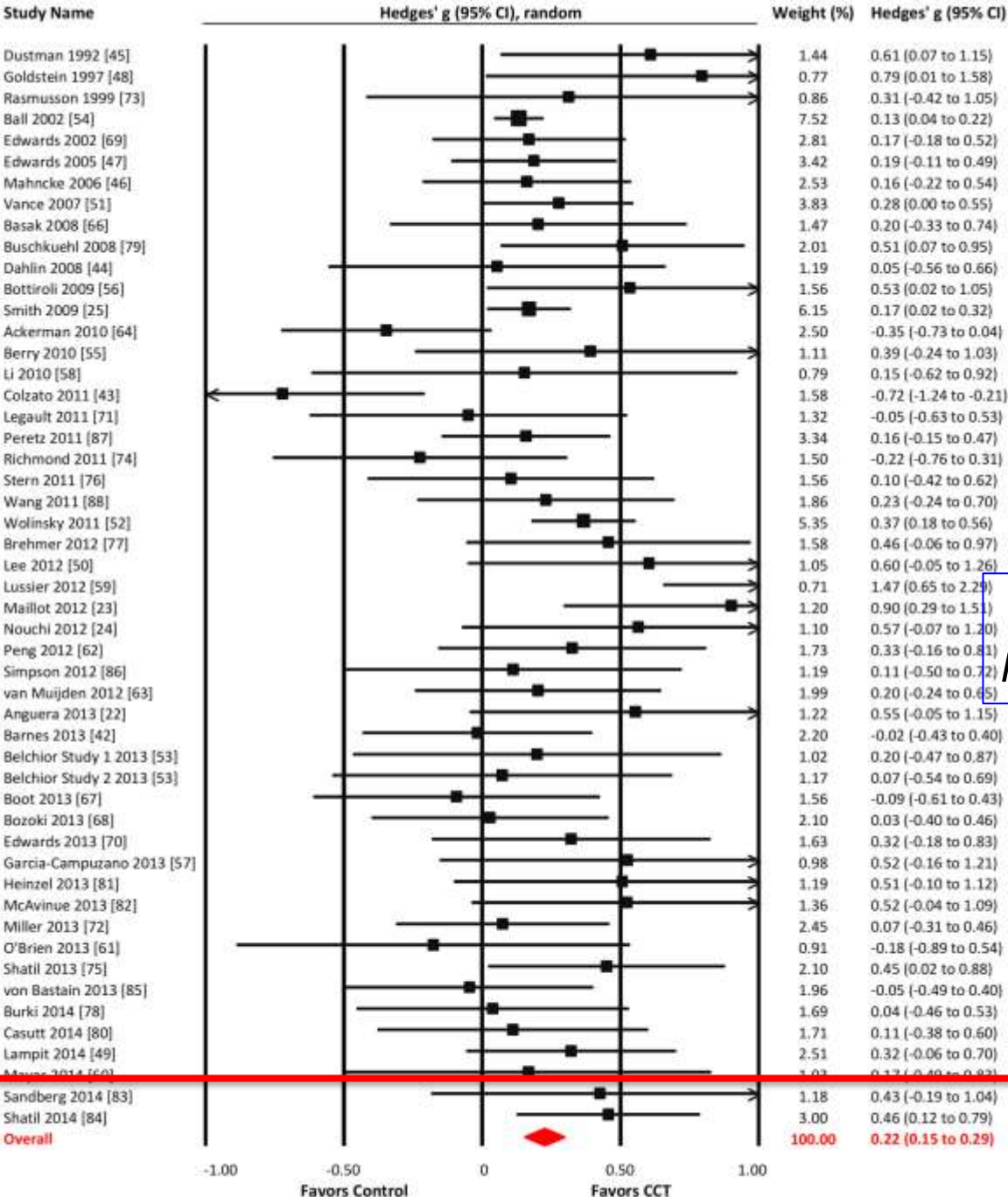
# Aims

- 1) To evaluate the efficacy tightly-defined CCT on cognitive outcomes
- 2) To assess the quality of RCT evidence
- 3) Test the moderating effects of key study design features
- 4) Suggest recommendations for future trial designs

# Inclusion criteria

- Randomised controlled trials of tightly-defined computerised cognitive training (CCT) programs (>4 hours of training)
- Cognitively healthy participants aged >60 years
- Published until July 2014
- Pre- post performance in neuropsychological tests compared to control





# Overall efficacy

- 52 RCTs, 4,885 participants
- 396 data points (cog outcomes)

**Overall cognitive effect (Hedges' g)**  
**g = 0.22 95% CI (0.15 to 0.29)**

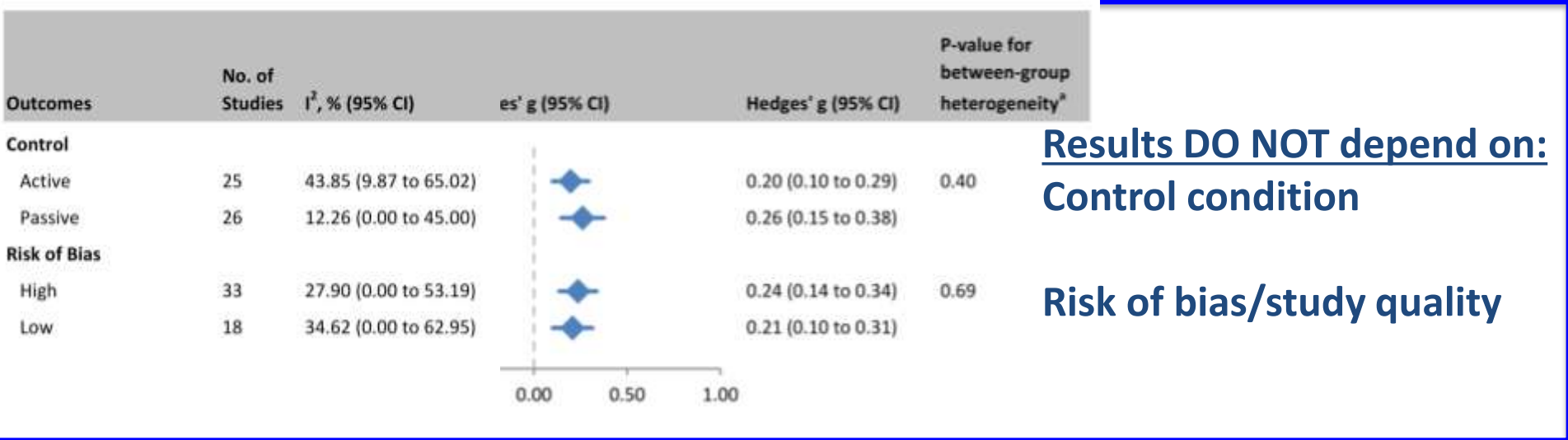
**Low-moderate heterogeneity**  
 $I^2=29.92\%$ , 95% CI [0.63 to 50.57%]

Lampit, A., Hallock, H., & Valenzuela, M. (2014). Computerized cognitive training in cognitively healthy older adults: a systematic review and meta-analysis of effect modifiers. *PLoS Medicine*, 11(11), e1001756. doi: 10.1371/journal.pmed.1001756

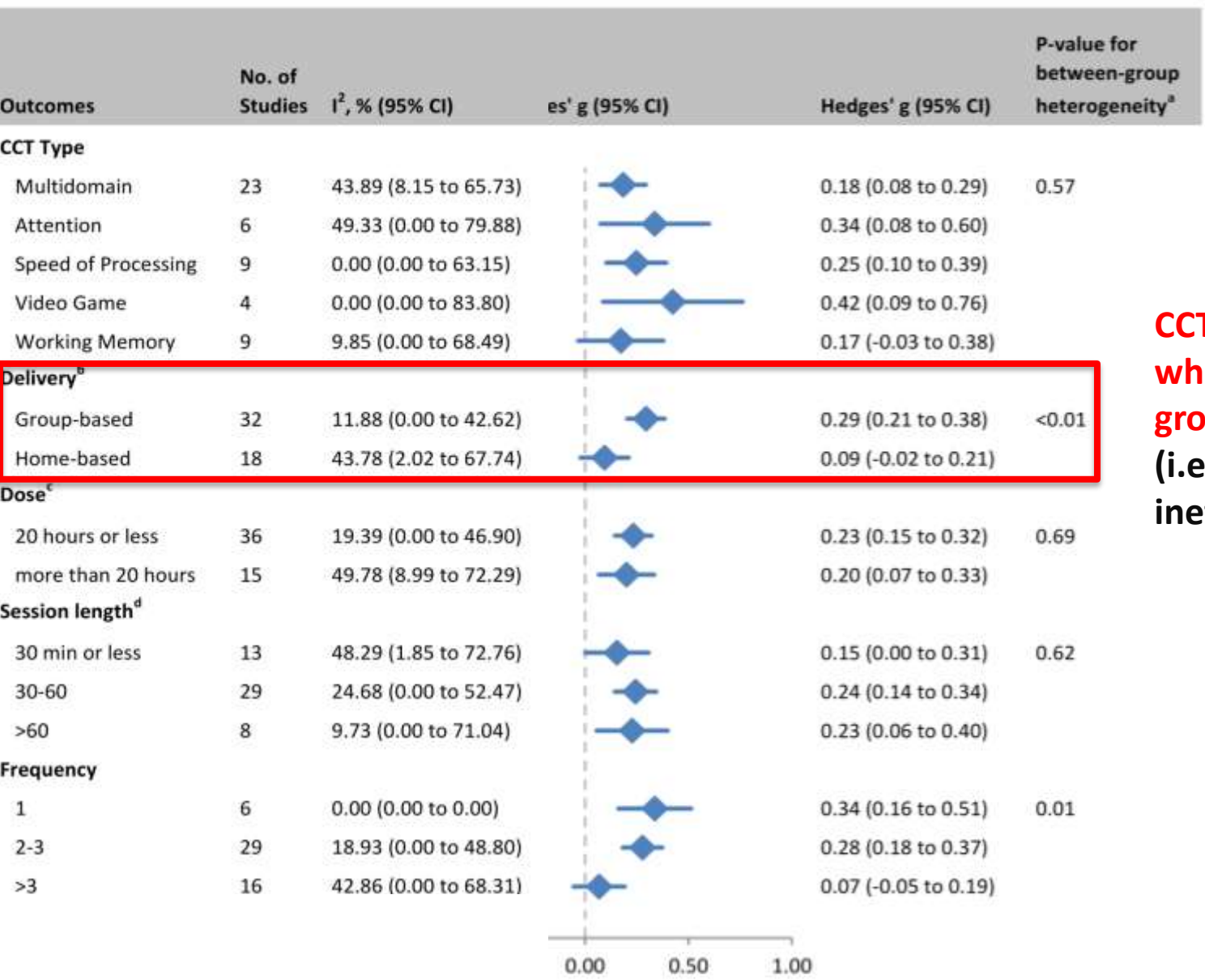
Tests for heterogeneity:  $\chi^2=71.35$ ,  $df=50$ ,  $P=0.03$ ,  $I^2=29.92$  (0.63 to 50.57)  
 Test for overall random effect:  $Z=6.07$ ,  $P<0.001$

# Quality of evidence

- No evidence of small study effect ('publication bias')
- 50% of studies were active controlled
- Assessors were blinded in 46% of studies
- Mean quality score = 6.2/9 (SD 1.35)



# Moderator analyses (overall effects)

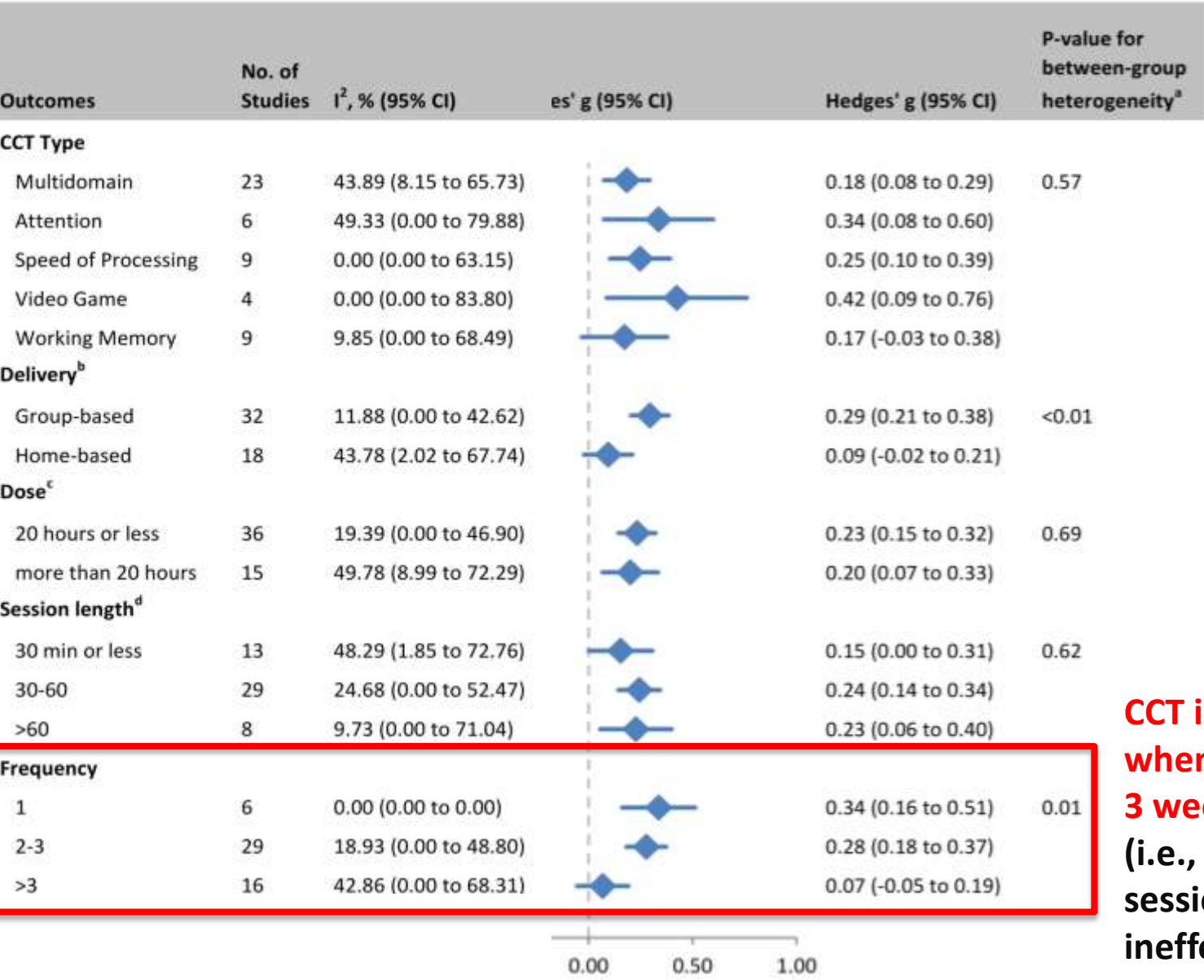


**CCT is only effective when delivered in group-based format (i.e., home training is ineffective)**

Lampit, A., Hallock, H., & Valenzuela, M. (2014). Computerized cognitive training in cognitively healthy older adults: a systematic review and meta-analysis of effect modifiers. *PLoS Medicine*, 11(11), e1001756. doi: 10.1371/journal.pmed.1001756



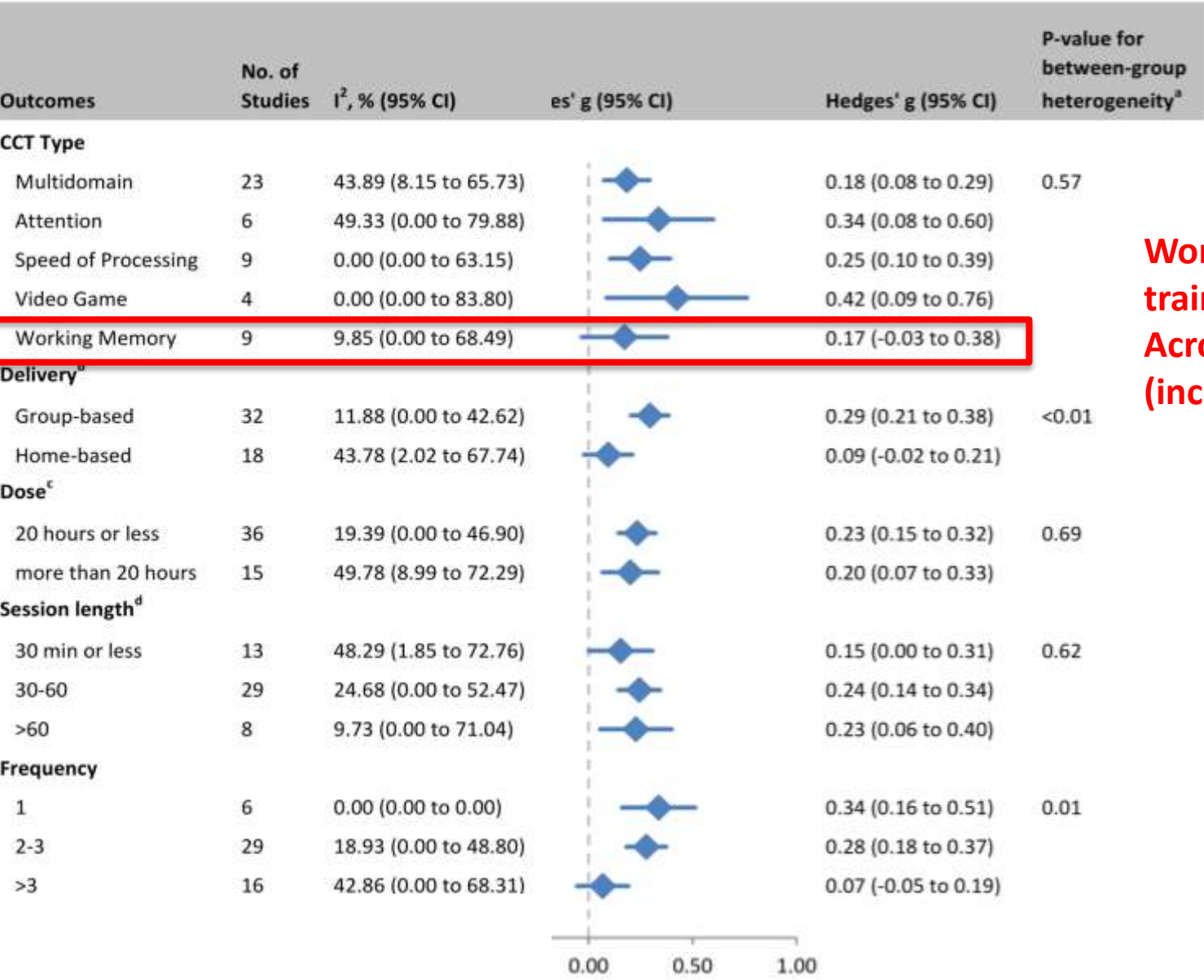
# Moderator analyses (overall effects)



**CCT is only effective when delivered in 1-3 weekly sessions (i.e., more than 3 sessions per week is ineffective)**

Lampit, A., Hallock, H., & Valenzuela, M. (2014). Computerized cognitive training in cognitively healthy older adults: a systematic review and meta-analysis of effect modifiers. *PLoS Medicine*, 11(11), e1001756. doi: 10.1371/journal.pmed.1001756

# Moderator analyses (overall effects)



**Working memory training is ineffective Across all domains (including WM)**

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		Overall	Processing speed	Non-verbal memory	Visuospatial	Working memory	Verbal memory <sup>p</sup>	Attention	Executive functions
All studies		0.22**	0.31**	0.24**	0.22*	0.22**	0.08*	0.24	0.09
CCT type	Multidomain	0.18**	0.16	0.25*	0.41	0.29**	0.13*	0.28	0.14
	Attention	0.34*	0.20		0.42 <sup>b</sup>	0.21	-0.27	0.54	0.20
	Speed of Processing	0.25**	0.53**	0.08	0.17	0.08	0.00 <sup>b</sup>	-0.01 <sup>b</sup>	0.04
	Video Game	0.42*	0.56	0.44	0.52 <sup>b</sup>	-0.04 <sup>b</sup>	1.43***	-0.06 <sup>b</sup>	0.39
	Working Memory	0.17	0.26	0.52 <sup>b</sup>		0.23	0.23	0.17	-0.09
Delivery	Group-based	0.29**	0.38**	0.32**	0.36**	0.22*	0.07	0.30	0.13
	Home-based	0.09	0.11	0.03	-0.05 <sup>b</sup>	0.21*	0.10	0.19	0.02
Dose	20 hours or less	0.23**	0.34**	0.18	0.10	0.28**	0.05	0.21	0.04
	more than 20 hours	0.20**	0.24	0.33**	0.60**	0.09	0.14*	0.34	0.20*
Session Length	30 min or less	0.15*	0.03	0.14	0.19	0.28*	0.12	0.14	0.09
	31-60 minutes	0.24**	0.33**	0.23*	0.33*	0.20*	0.15**	0.39	0.09
	>60 minutes	0.23**	0.42*	0.50*	0.52 <sup>b</sup>	-0.04 <sup>b</sup>	0.01	-0.06 <sup>b</sup>	0.07
Frequency	1 session/wk	0.34**	0.51*	0.18	0.18 <sup>b</sup>	0.16	0.38	-0.01 <sup>b</sup>	-0.04 <sup>b</sup>
	2-3 sessions/wk	0.28**	0.36**	0.35**	0.43**	0.30**	0.05	0.32	0.16*
	>3 sessions/wk	0.07	0.10	-0.10	-0.05 <sup>b</sup>	0.12	0.11	0.22	-0.02
Control	Active	0.20**	0.24	0.29**	0.46*	0.23**	0.14*	0.20	0.02
	Passive	0.26**	0.37**	0.16	0.21	0.21*	0.04	0.32	0.19*
Risk of Bias	High	0.24**	0.23*	0.19	0.32*	0.22**	0.17*	0.33*	0.11
	Low	0.21**	0.43**	0.30**	0.30	0.23	0.05	-0.04	0.06

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# Conclusions: Practice

1. There is sufficient evidence to support implementation of cognitive training for older adults
2. Training should be conducted in supervised environment, 2-3 times per week, ~60 minutes per session
3. Solo training at home is not likely to be beneficial
4. Multidomain programs are most likely to improve overall cognition. Avoid single-domain programs (e.g., programs that focus only on working memory)

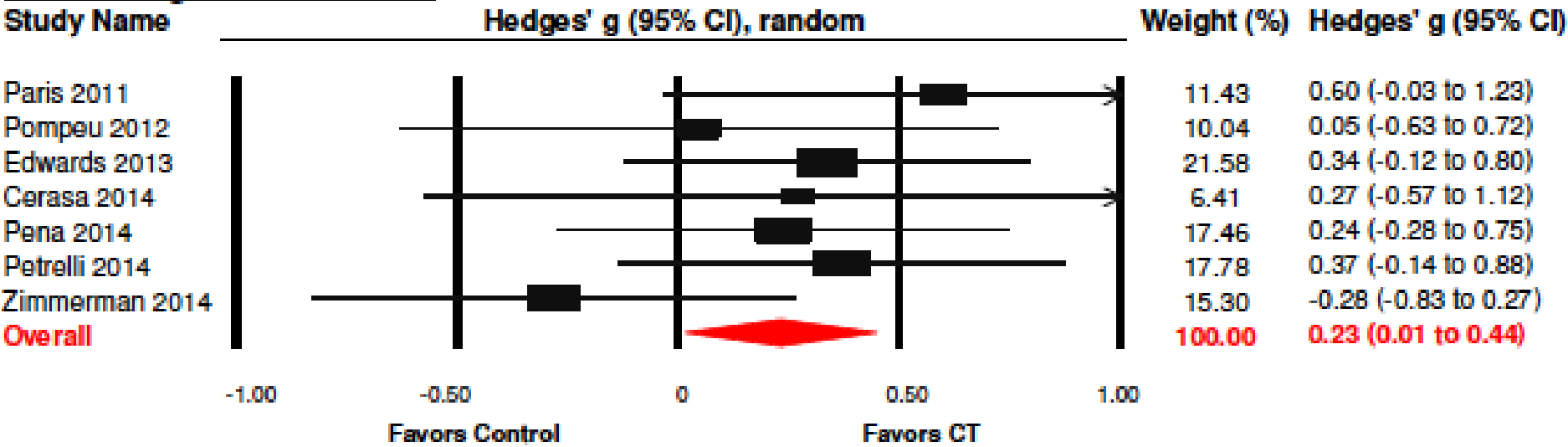


# Conclusions: Research

1. Move beyond mere efficacy, e.g.:
  - Maintenance of gains
  - Effectiveness in clinical populations
  - Effects on other outcomes
  - New models of delivery
2. Head-to-head comparisons rather than active-controlled trials
3. Interactions with other interventions

# Efficacy in Parkinson's disease

## Overall cognitive outcomes



Tests for heterogeneity:  $\chi^2=5.48$ ,  $df=6$ ,  $P=0.484$ ,  $I^2=0$   
 Test for overall random effect:  $Z=2.09$ ,  $P=0.037$

**Significant improvements in:**  
 Working memory  
 Executive functions  
 Speed

Leung et al (under review)

