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Your new best friend, heterogeneity

Diverse evidence types and diverse methods to address explanatory questions in systematic reviews

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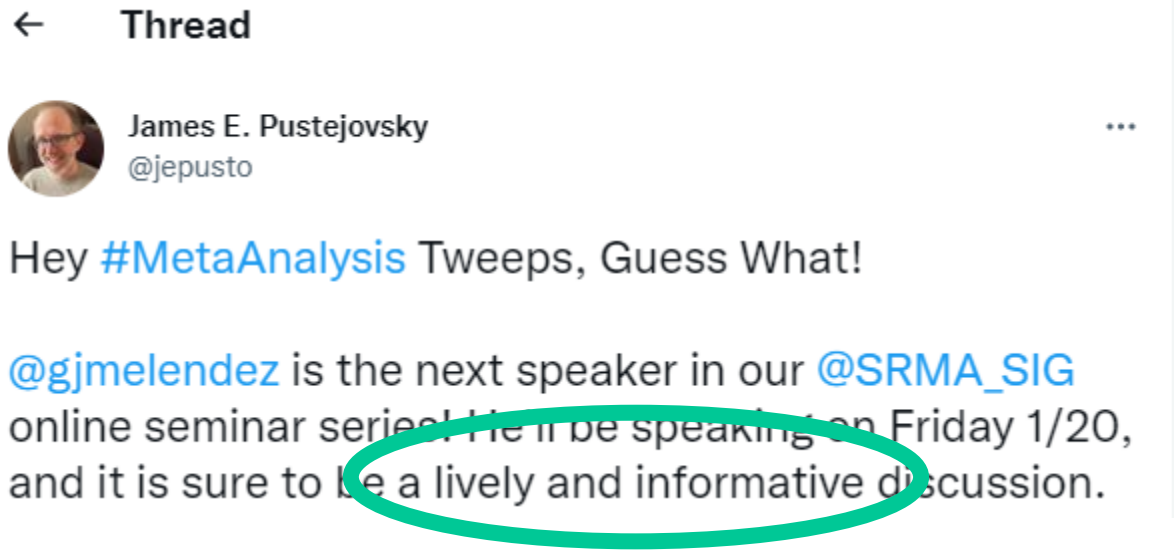
Hello from England's South West!

THE RIGHT WAY!

OK, now for today's presentation: learning outcomes

- Attendees will no longer experience alarm in the face of heterogeneity
- Attendees will no longer experience helplessness in the face of heterogeneity
- Attendees will come to appr
- Attendees will no longer def



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Heterogeneity as a precondition to explanation

- Explanation: beyond ‘this works’ to…
  - ‘this intervention works better’
  - ‘this is a reason why some interventions work and others don’t’
  - ‘this is a model to understand why interventions work’
- Explanation is central to social science
- Most systematic reviews stop at inferential/predictive reasoning…
- …when clinical/configurational reasoning can take study findings beyond ‘does it work?’ (Melendez-Torres et al., 2016)

Different methods to account for heterogeneity work in different ways

- Left-hand side vs right-hand side heterogeneity
- Explanatory accounts of heterogeneity can be deductive, abductive or inductive
- …and the resulting explanations can be confirmatory or exploratory
- This depends on context of application ('is this a good policy?' vs 'will it work here?'; Bonell et al., 2021)
- I am still thinking about this, so thoughts are welcome!

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Network meta-analysis in a social science context: deductive reasoning

- Network meta-analysis: comparative effectiveness of intervention strategies
- Heterogeneity in the contrast with a lumping approach
- Uneasy but exciting translation from clinical to psychosocial: how are network nodes formed?
- No longer pharmacological interventions…
- …but important questions about using network nodes to test explanatory hypotheses

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Node-making in network meta-analysis offers explanatory opportunities

- Default methods (Melendez-Torres, Bonell & Thomas, 2015):
  - components and dismantling
  - clinically meaningful units
- However, these presume that the scope of hypotheses is limited to programme content
- …in reality, the policy-relevant decision may require different explanatory hypotheses

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School-based prevention of dating and gender violence: STOP DRV GBV

- Farmer et al. (2023): forthcoming in ***American Journal of Public Health***
- Large-scale NIHR-funded systematic review of school-based interventions
- Meta-analysis included 68 trials
- Key policy and practice questions: how extensive? how to maximise efficiency? how long until we know something works?

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Pairwise meta-analyses used random effects, robust variance estimation

Outcome	Short-term follow-up (<1 year)				Long-term follow-up (≥1 year)			
	k	n	OR (95% CI)	I^2 (%)	k	n	OR (95% CI)	I^2 (%)
DRV victimisation	17	118	0.90 (0.80, 1.02)	81	13	79	0.82 (0.68, 0.99)	80
DRV perpetration	18	118	0.91 (0.80, 1.04)	83	16	79	0.78 (0.64, 0.94)	79

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Two questions remain: how extensive? how to maximise efficiency?

- We consulted policy and practice colleagues, and young people
- We categorised interventions by delivery type, breadth of mechanism, and scope of implementation
  - Single-component: ‘one-hit wonders’, generally externally facilitated
  - Curriculum: integration into existing health lessons
  - Multicomponent: several moving parts, but not targeting structural mechanisms
  - Multilevel: several moving parts over several levels, including structural mechanisms
- Importantly, categorisation was undertaken without knowledge of outcomes

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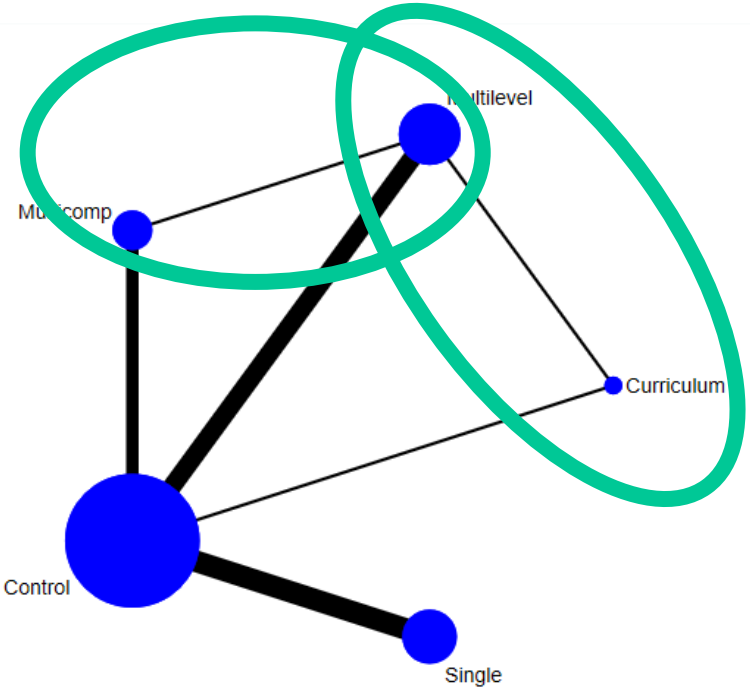
NMA for long-term DRV victimisation

- A key benefit of NMA is inclusion of head-to-head evidence
- Several trials contributed this evidence and were able to be included as a result



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Frequentist NMA was implemented in Stata: DRV victimisation, long-term

	Control	Single	Curriculum	Multicomponent	Multilevel
Control	1	0.60 (0.41, 0.86)	0.92 (0.61, 1.40)	0.94 (0.73, 1.20)	0.83 (0.69, 1.00)
Single		1	1.54 (0.88, 2.69)	1.57 (1.01, 2.45)	1.39 (0.92, 2.10)
Curriculum			1	1.02 (0.63, 1.66)	0.90 (0.62, 1.31)
Multi-component				1	0.88 (0.65, 1.21)

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Frequentist NMA was implemented in Stata: DRV victimisation, long-term

- We then bootstrapped resultant estimates to generate rankings
- These rankings do not suggest that multilevel interventions are a 'best bet'

	Control	Single	Curriculum	Multi-comp	Multilevel
Best	0	90.3	4.8	1.1	3.8
2nd	0.4	6.6	21.6	17.7	53.7
3rd	12.5	2.3	23	26.9	35.3
4th	44.7	0.4	18.3	30	6.6
Worst	42.4	0.4	32.3	24.3	0.6

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STOP DRV GBV: key takeaways

- We can test more and different kinds of hypotheses in psychosocial NMAs
- These generated a (null) explanatory account of heterogeneity…
- …that is, complexity or complicatedness of interventions do not provide a particularly satisfactory account of heterogeneity
- A confirmatory account of this finding, supported by several parallel syntheses, is that it may be more important to do something well than to do something complicated

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Abductive methods

- Abductive methods blend inference to the best explanation, partially deductive approaches, and partially inductive approaches
- Many studies, many variables: latent class analysis with NMA
- Few studies, many variables: qualitative comparative analysis

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Many studies, many variables: latent class analysis with NMA

- Leijten, Melendez-Torres & Gardner (2022) in ***Journal of Child Psychology and Psychiatry***
- We included 197 trials (including 430 trial arms) of parenting programmes (many of which are branded) for disruptive child behaviours
- High levels of left-hand side and right-hand side heterogeneity: we labelled all trial arms according to absence of presence of 19 intervention components
- …too many meta-regressions!
- An important question was if the ways components stuck together could tell us something about effectiveness that went beyond brands

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Latent class model on trial arms suggested five classes were optimal

	2 Classes	3 Classes	4 Classes	5 Classes	6 Classes
BIC	3,089	2,279	2,159	2,165	2,242
aBIC	2,966	2,091	1,908	1,851	1,864
AIC	2,931	2,039	1,838	1,763	1,758
cAIC	3,128	2,338	2,238	2,264	2,361
Entropy	98.7%	99.6%	98.5%	97.50%	97.6%

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Latent class model on trial arms suggested five classes were optimal

- Behaviour management
- Behaviour management with parental self-management
- Behaviour management with psychoeducation and relationship enhancement
- Monster truck
- Control

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Now, a statistical quandary…

- Latent class analysis measures class assignment with error
- All meta-analytic methods include an estimate of error on the effect size
- How do we account for right-hand side and left-hand side error?
- Pseudo-class imputations
  - Take 20 ‘multiply imputed’ draws of class distributions
  - Estimate NMAs on each of them (including χ^2 LRTs for inconsistency)
  - Combine results using Rubin’s rules

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The slimmest programmes appeared to be the most effective

	Behaviour management	BM with self-management	Monster truck	BM, psychoed, relationship	Control
Behaviour management	0	-0.14 (-0.35, 0.07)	-0.21 (-0.42, -0.01)	-0.24 (-0.47, -0.004)	-0.66 (-0.78, -0.55)
BM with self-management		0	-0.07 (-0.32, 0.17)	-0.09 (-0.37, 0.18)	-0.52 (-0.70, -0.35)
Monster truck			0	-0.02 (-0.29, 0.24)	-0.45 (-0.62, -0.28)
BM, psychoed, relationship				0	-0.43 (-0.64, -0.22)
Control					0

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Latent class with NMA: key takeaways

- We can test **even more** and different kinds of hypotheses in psychosocial NMAs
- The explanatory account of heterogeneity we generated suggests both what kinds of interventions should be tested next…
- …but also what kinds of interventions may be most reliably effective
- The use of latent variable methods can help capture the 'spirit' of interventions in ways that manual classification may not pick up
- Confirmatory? Exploratory?

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Few studies, many variables: qualitative comparative analysis

- A different approach to causation
- Configurational, not successionist
- Combinations of causes, not single-cause
- Sufficient (and necessary) causation, not net effects
- Can be used alongside ‘standard’ meta-analysis

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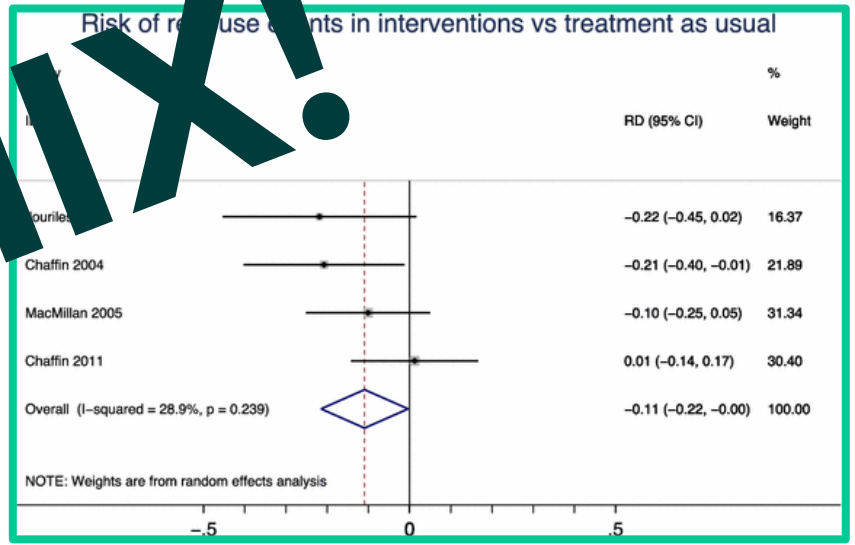
Parenting programmes to prevent child physical abuse recurrence

- Vlahovicova et al., 2017 in ***Clinical Child and Family Psychology Review***
- Of 14 included trials, seven presented child abuse recurrence outcomes, but only four were meta-analysable
- Another three trials used survival analysis
- Remaining trials reported a potpourri of outcomes linked to child abuse…

REMIX!



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Parenting programmes to prevent child physical abuse recurrence: remix!

- Melendez-Torres, Leijten & Gardner (2019) in ***Child Abuse Review***
- Of the 14 trials, 10 trials compared interventions vs minimal controls, with a total of 14 comparisons
- We calibrated interventions as 'most effective' (n=9) or 'least effective' (n=5) effective by considering effect sizes: first, on official records of re-abuse; second, on self-reported measures of child abuse; and third, on observational measures of harsh and hostile parenting
- We then labelled interventions as to the presence or absence of components from a theoretically led list

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Parenting programmes to prevent child physical abuse recurrence: remix!

- We then examined the distribution of different components across conditions, and their ability to discriminate between most and least effective
- Our analysis included ***non-violent punishment strategies***, ***proactive parenting strategies***, and ***attachment-focused strategies*** as key factors
- Factors relating to ***psychoeducation*** and ***empathy***, which we expected would be useful in distinguishing between most and least effective interventions, were not useful!
- Instead a new category, ***parental self-management***, emerged as important to distinguish between most and least effective interventions

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Qualitative comparative analysis leads to Boolean minimisation

Pathways to …	Minimised solution
Most effective interventions	alternative punishment AND (**no** self-manage AND **no** proactive parenting, OR self-manage AND proactive parenting) OR **no** attachment AND alternative punishment
Least effective interventions	**no** self-manage AND (**no** attachment AND **no** alternative punishment AND **no** proactive parenting, OR attachment AND alternative punishment AND proactive parenting)

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Qualitative comparative analysis leads to Boolean minimisation

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Do one thing and do it well, or do a lot and teach parents to manage their stress

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Qualitative comparative analysis leads to Boolean minimisation

Pathways to …	Minimised solution
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Doing too much… or not doing enough

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QCA: key takeaways

- Causal pathways as theory-generating, as opposed to meta-analyses as theory testing
- Account for diverse outcomes that point closely to the same construct: left-hand side and right-hand side heterogeneity
- Exploratory rather than confirmatory; contribute to developing understanding as opposed to ‘finalising’ a model
- Abductive reasoning starting with theory-led models, then iterating explanation
- (Other ways to identify conditions include user views; cf. Sutcliffe et al., 2018)

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Inductive methods: realist synthesis

- Leaning all the way into heterogeneity: diverse contexts, diverse study types, diverse outcomes all key to generating an informative realist synthesis
- Realist synthesis is explanatory: how do interventions work (mechanisms), where (contexts) and towards which outcomes?
- Context-mechanism-outcome configurations are a cornerstone of realist analysis; together, they comprise a developing programme theory
- Analysis is not dissimilar from grounded theory (but don't quote me on that)

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STOP DRV GBV: concluding with realist synthesis

- Our concluding realist synthesis drew on 249 papers…
  - Theories
  - Components
  - Implementation
  - Effectiveness (pairwise and network meta-analyses)
  - Mediation
  - Equity impacts
- Used combination of meta-regression, NMA and QCA as ‘theory consolidation’ steps

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STOP DRV GBV: realist synthesis

- We used findings from parallel syntheses in an iterative, constant comparative method to generate a new explanatory framework for included interventions
- We used this to explain patterns of effectiveness that were better and more consistent for DRV than GBV
- We also accounted for NMA findings regarding complexity of interventions
- Analysis was undertaken over several cycles of investigator meetings

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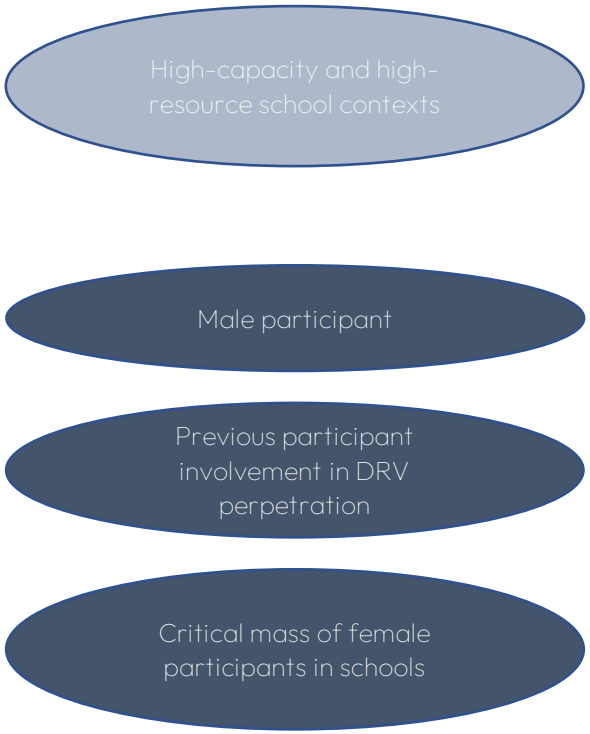
STOP DRV GBV: realist synthesis



Social transformation mechanism

Multilevel intervention stacked on student-level intervention, including assessment of fit	Reframing of acceptable behaviours and violence acceptance	Prevention of GBV victimisation via prevention of perpetration

Basic safety mechanism

Student-level intervention incorporating single-gender sessions, guided practice and focus on relationships	Negative attitudes to violence & ability to apply to relationships	Prevention of DRV victimisation via prevention of perpetration

Summing up

- Learning to love heterogeneity… in all its forms… requires knowing what to do with it
- Matching explanatory methods to heterogeneity requires thinking through what kinds of heterogeneity: left-hand side or right-hand side (or both)
- Whether explanatory accounts are confirmatory or exploratory remains an open question—possibly determined by scope of application

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Thank you

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