Jenny Terry & Andy Field

The Fault in our STARS: The Lack of Discriminant Validity in Statistics and Maths Anxiety Measures

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Background/Aim:

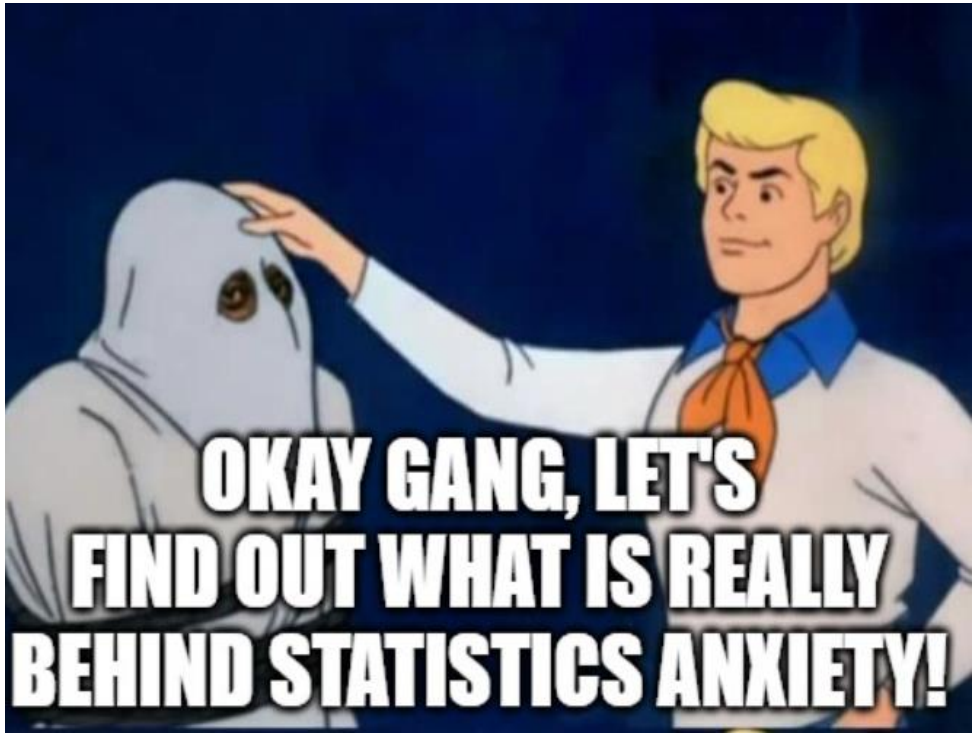
- To promote statistical literacy, we must identify and address emotional and attitudinal barriers to learning statistics with research using robust methods and measurement
- Statistics anxiety is often cited as such a barrier, but we know little about its construct validity
- Of particular concern, statistics anxiety is defined as distinct from mathematics anxiety (Cruise et al. 1985, Chew & Dillon, 2014), yet few empirical studies have tested this assumption
- Existing findings suggest the ubiquitously used measure of statistics anxiety, the Statistics Anxiety Rating Scale (STARS; Cruise et al. 1985) measures something distinct from maths anxiety scales (e.g. Paechter et al., 2017), but reported differences are based primarily on correlations and could be due to various methodological limitations
- To address these issues, we re-evaluated the discriminant validity of the STARS in three novel ways
- No directional predictions were made

Participants: *N* = 465 undergraduate psychology students in the UK (age: *M* = 20.5, *SD* = 2.8; gender identity: 79% female, 19% male, 0.65% non-binary)

Measures:

- Statistics anxiety - STARS (Cruise et al., 1985)
- Maths anxiety - R-MARS (Baloğlu & Zelhart, 2007)
- A statistics version of the R-MARS and a maths version of the STARS
- State/trait anxiety – STICSA (Ree et al., 2008)

Procedure: Participants completed online self-report questionnaires (STARS, R-MARS, the modified versions, trait anxiety, and pre-manipulation state anxiety), followed by a between-participants experimental manipulation (multiple-choice test: statistics or mathematics), and a post-manipulation state anxiety questionnaire.



Scan for pre-registration, data, R code, a copy of this poster, references, & more!

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Analysis #1: Exploratory factor analysis of all four statistics and maths anxiety measures

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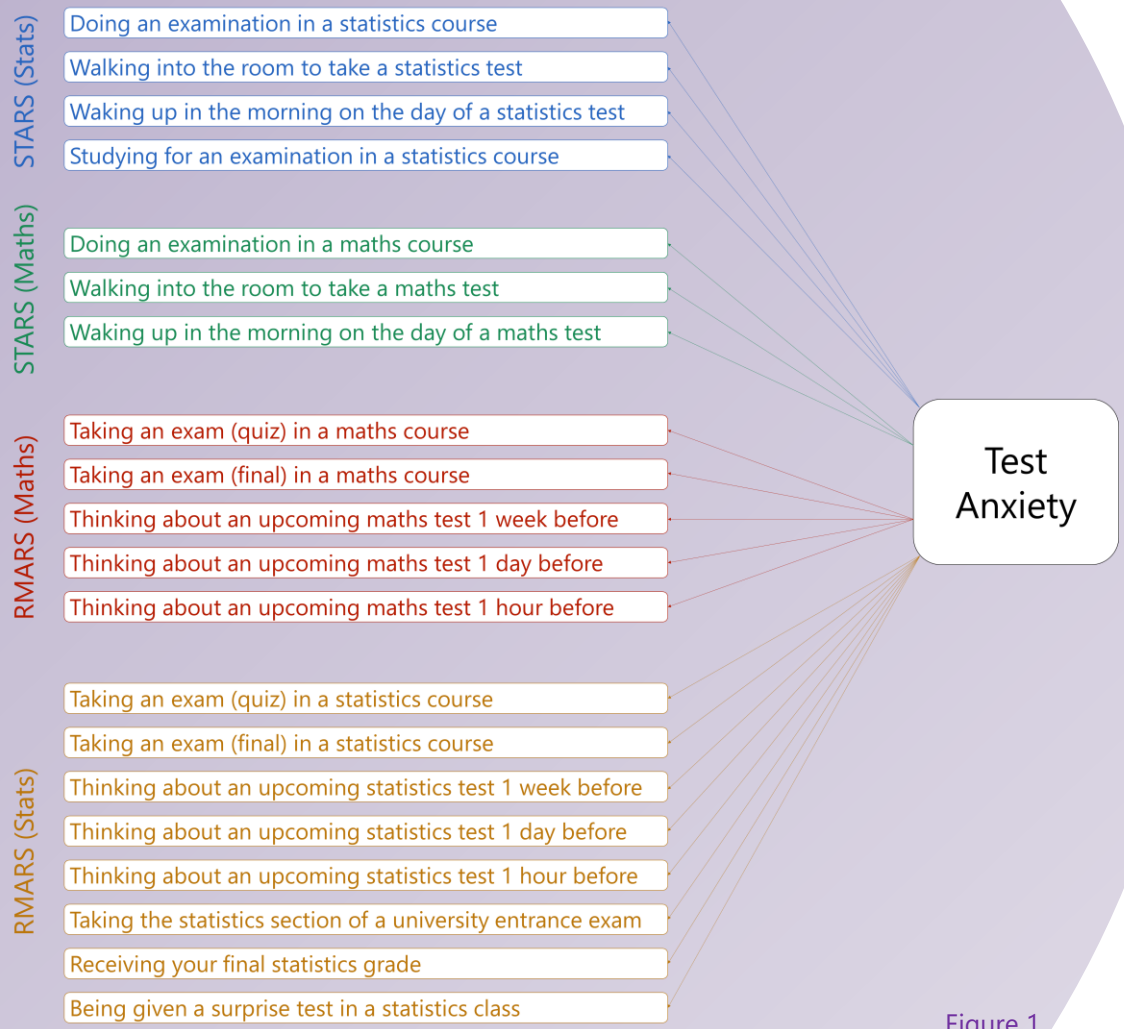

Figure 1

Exploratory factor analysis resulted in factors seemingly driven by a shared underlying construct. For example, Figure 1 shows that items from the test anxiety subscales of all four statistics and maths anxiety measures loaded onto a single test anxiety factor (loadings > .4 shown), not distinguishing between statistics and maths. This pattern was repeated for other items and subscales, revealing additional factors apparently driven by anxiety about academic activities (e.g. tests, studying, feedback) and not the subject being studied (i.e. statistics or maths). This suggests that what is driving responses is not specific to statistics or maths and the measures are not tapping something unique to the other.

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Analysis #2: Latent profile analysis of all four statistics and maths anxiety measures

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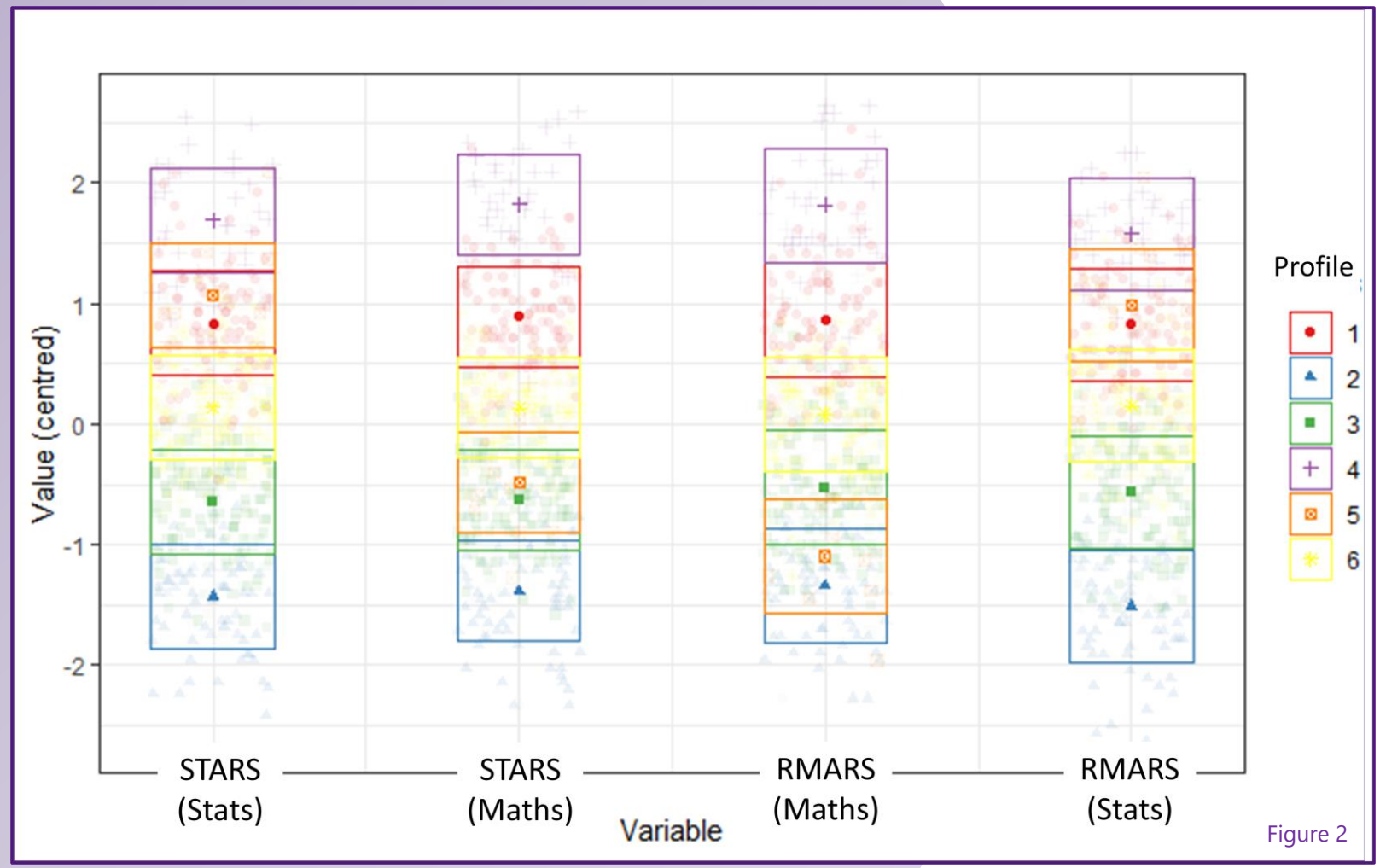

Figure 2

Latent profile analysis indicated 98% (*N* = 458) of participants had similar ratings on each of the maths anxiety and statistics anxiety scales (Figure 2). Only profile 5 deviated, whereby individuals had higher statistics anxiety than maths anxiety. No profiles contained individuals meaningfully higher in maths anxiety. This pattern suggests it is very unusual for an individual to report having statistics anxiety independently of maths anxiety or vice-versa, indicating they rarely develop independently and therefore may be the same construct.

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Analysis #3: Mixed effects analysis of state anxiety change after a maths or statistics MCQ test at different levels of maths and statistics anxieties

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Predicted mean values of state anxiety change at -1 *SD*, *M*, & +1 *SD* of **statistics anxiety** for each MCQ condition

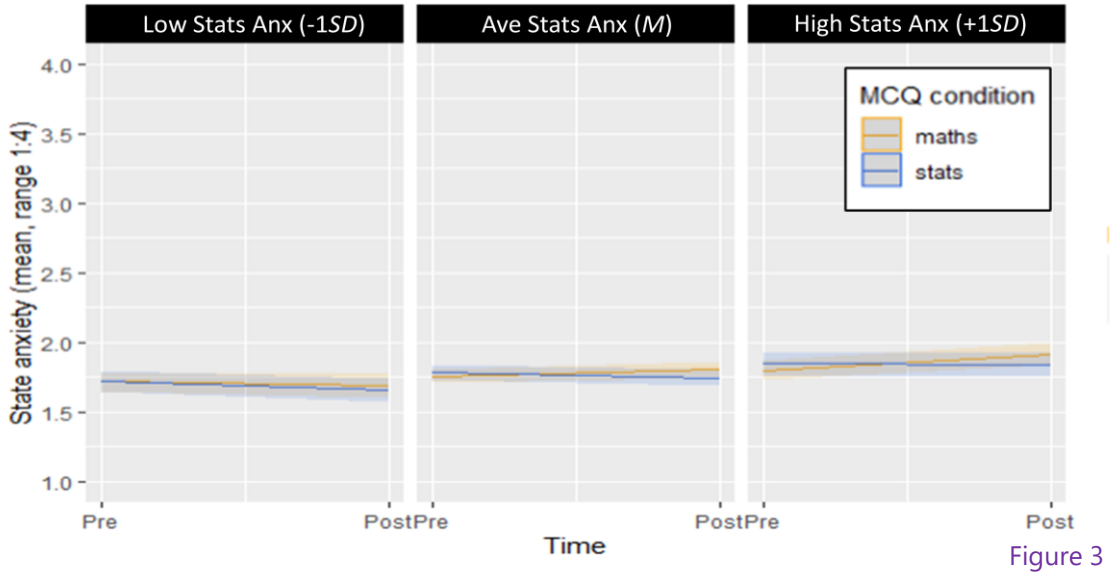

Figure 3

Predicted mean values of state anxiety change at -1 *SD*, *M*, & +1 *SD* of **maths anxiety** for each MCQ condition

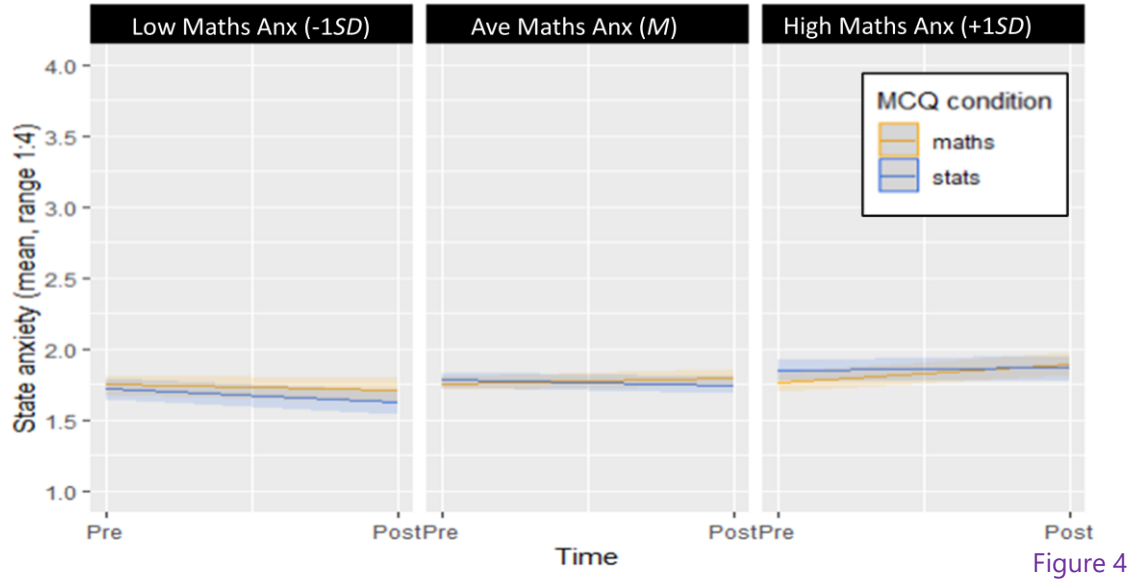

Figure 4

The two models showed state anxiety changes did not vary by MCQ type for either statistics-anxious, $\gamma = -0.04$, $p = 0.29$, 95% CI [-0.11, 0.034], or maths-anxious individuals, $\gamma = -0.02$, $p = 0.51$, 95% CI [-0.10, 0.05]. Furthermore, state anxiety change was similar for statistics-anxious (Figure 3) and maths-anxious (Figure 4) individuals, regardless of whether they did a statistics or a maths test. The STARS and R-MARS therefore showed no specificity in their predictive validity, indicative of a shared underlying construct.

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Conclusions & Future Research

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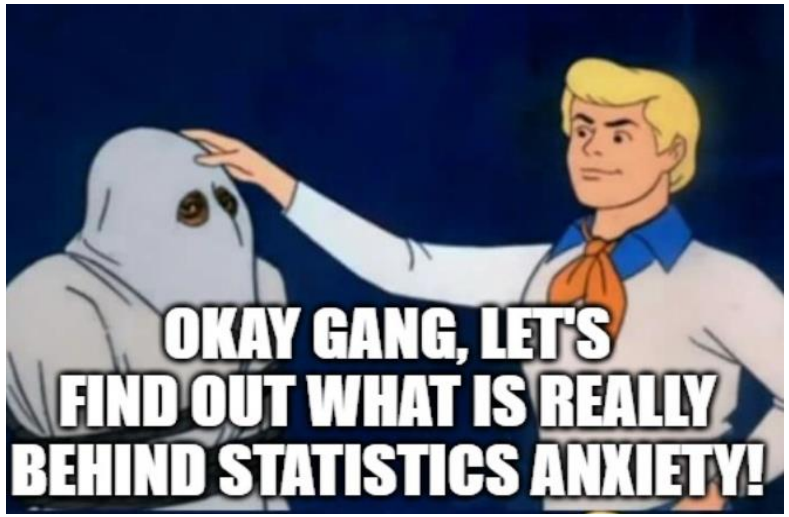
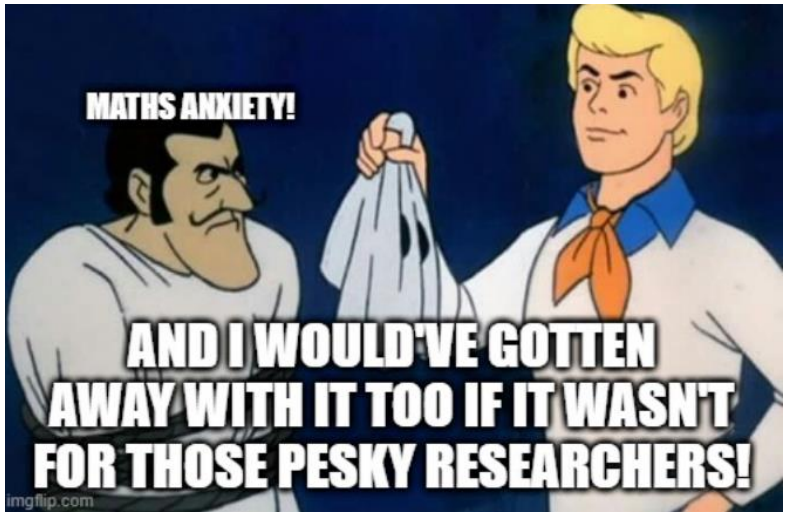
Conclusion:

- Results suggest statistics and maths anxieties may not be distinct constructs
- This may mean that statistics anxiety is maths anxiety in a different context, or something else might be driving both constructs
- We may have unearthed a *jangle fallacy* (i.e. two measures treated as unique that are actually the same; Kelley, 1927).
- Should further research support this conclusion, theory and empirical findings from both literatures would be mutually informative, expediting research progress
- Further, researchers should avoid including both constructs in studies to avoid statistical anomalies (e.g. multicollinearity)

Future research:

- An exact replication in a different sample (in progress)
- An international multi-lab study to examines what is driving maths and statistics anxieties (in progress)
- A multi-trait, multi-method study
- To explore the rare cases of individuals that score differently on each scale





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