

Should multiple choice items be used to assess mathematical knowledge?

- (a) Always**
- (b) Mostly**
- (c) Never**

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Rasch Day 2017, Coventry

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How to cheat an MC item

Factor: $45m^2 - 20$.

- (a) $(7m - 5)(7m + 5)$
- (b) $5(9m - 4)(9m + 4)$
- (c) $5(3m - 4)(3m + 4)$
- (d) $5(3m - 2)(3m + 2)$

Direct & inverse processes

Direct

Multiplication of numbers

Laws of exponents

Expanding brackets

Single fraction

Differentiation

Verify a solution

Inverse

Prime factoring of integers

Laws of logarithms

Algebraic factoring

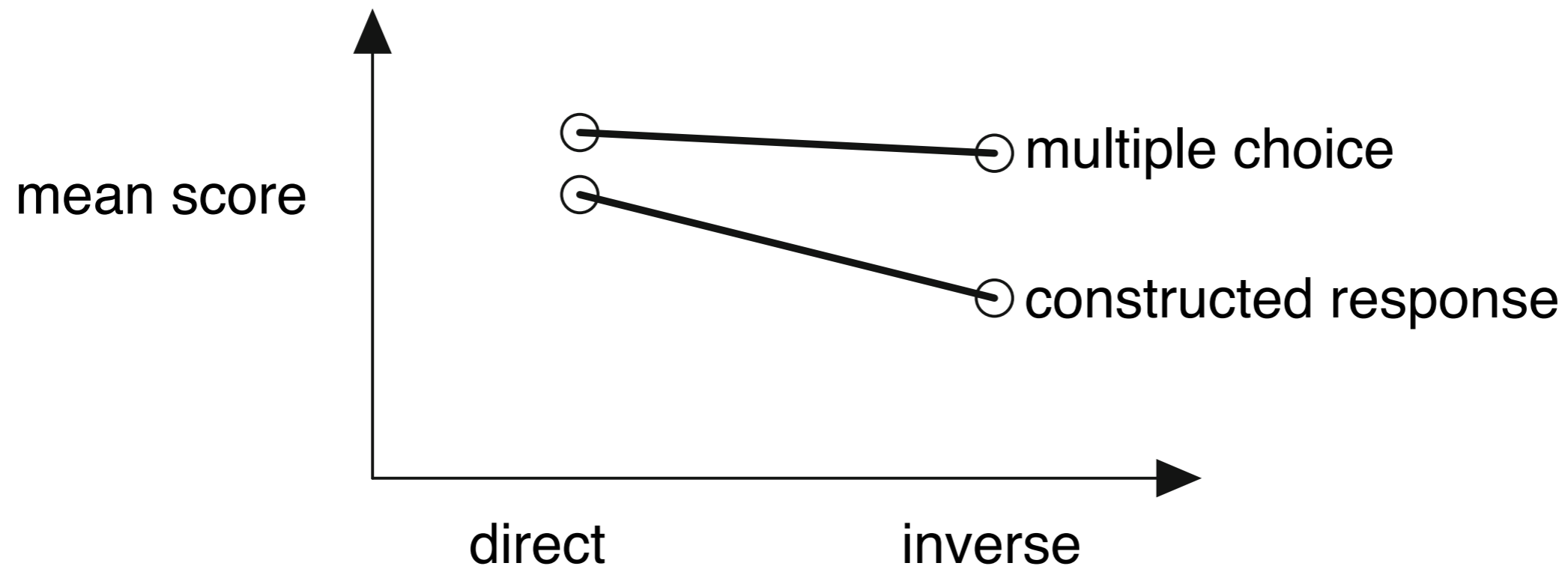
Partial fraction

Symbolic integration

Solve an equation

Hypothesis

When faced with a task involving the inverse direction of a reversible mathematical process, students solve a multiple choice version by verifying the answers by the direct method, not by undertaking the actual inverse calculation.

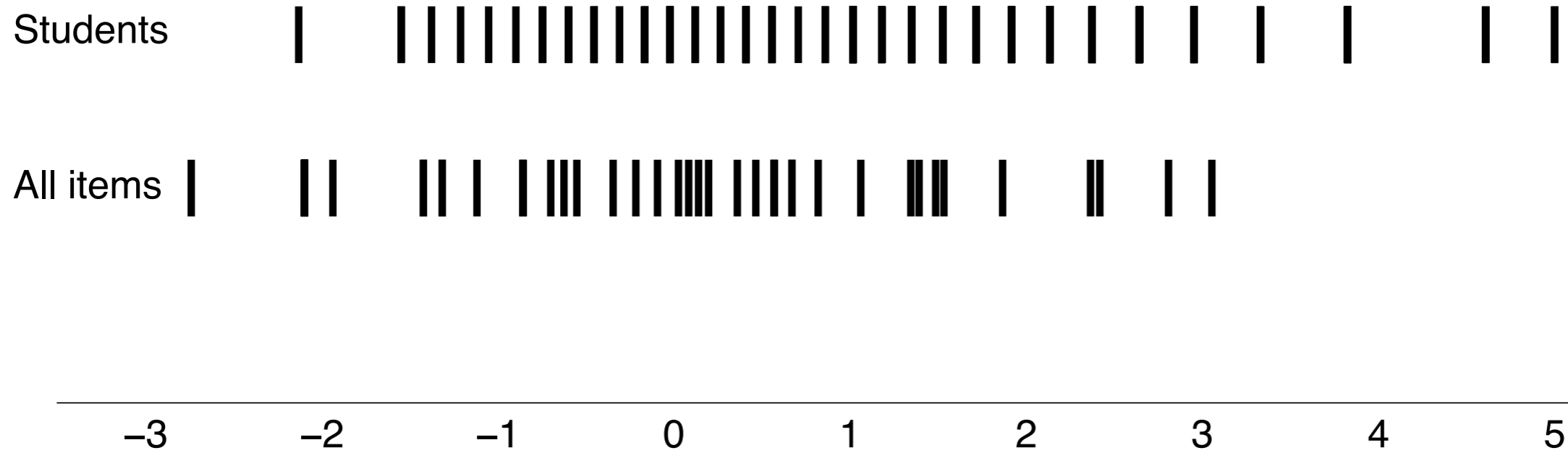


Method

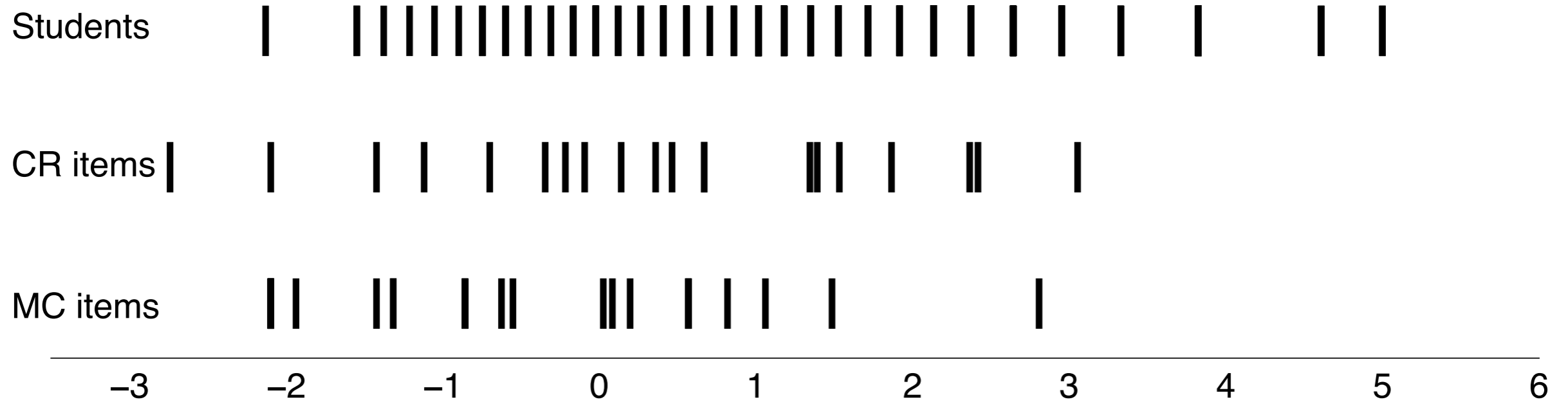
- 116 Foundation programme students
- Online test: 20 MC and 20 CR items
- Every item appeared twice, once in each version
- Cronbach's $\alpha = .91$

Process	Direct	Inverse
Expand/factor	5	5
Evaluate/solve	4	6

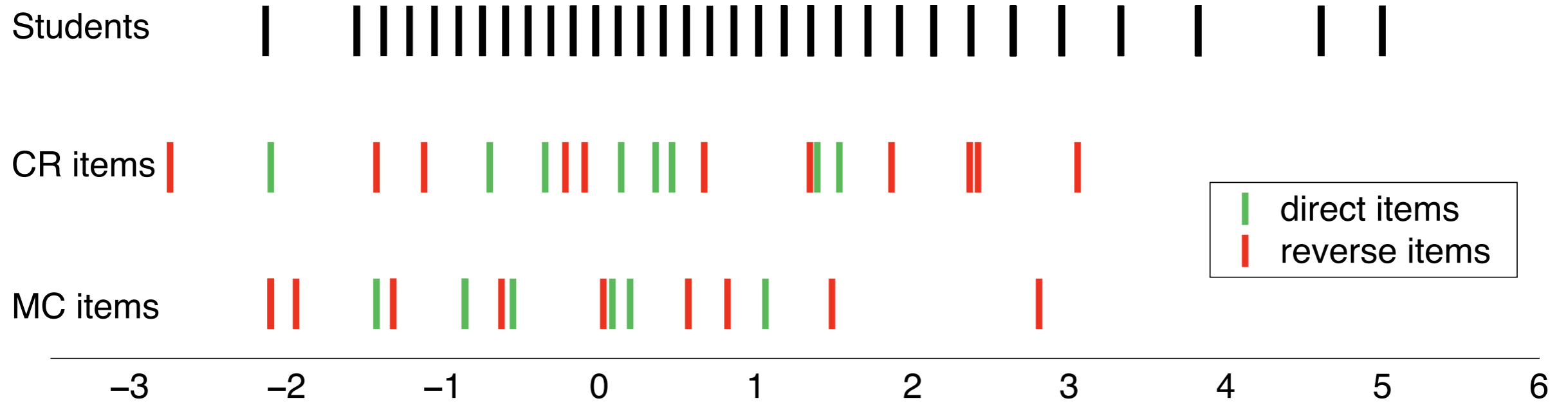
Students & items



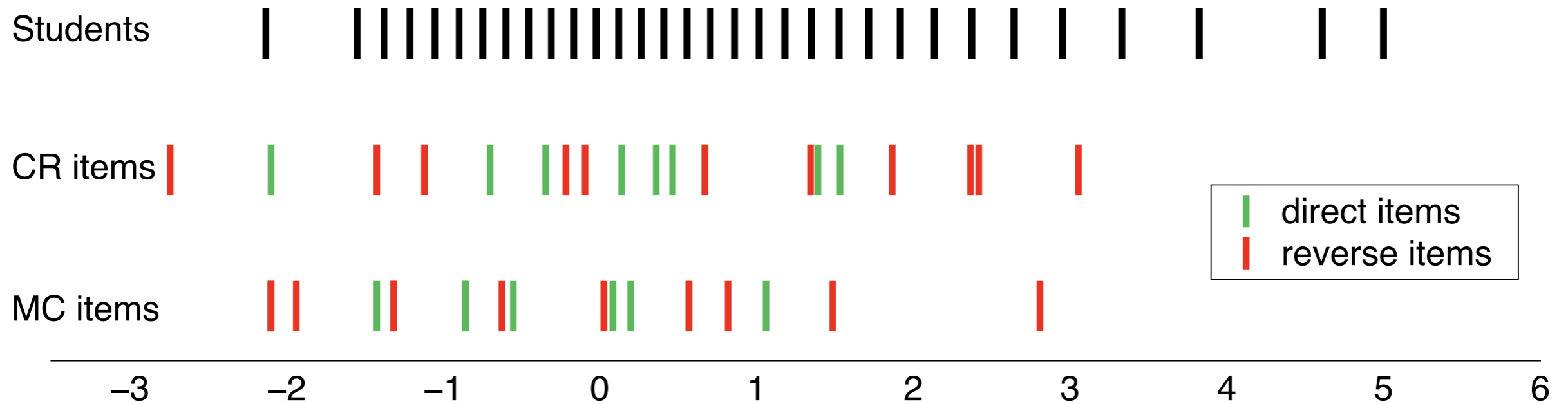
Items by format



Items by format and direction

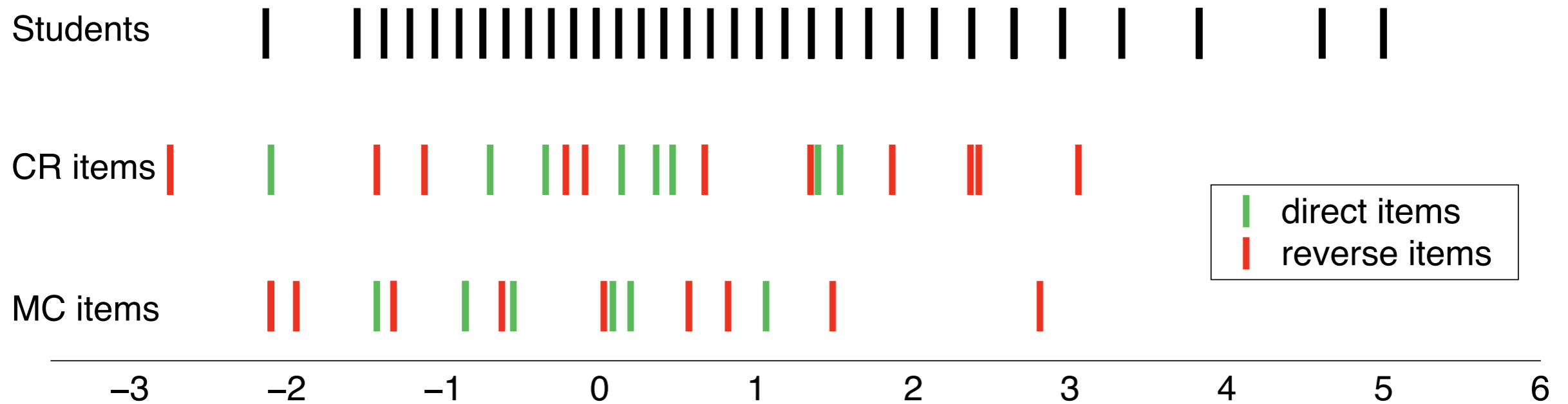


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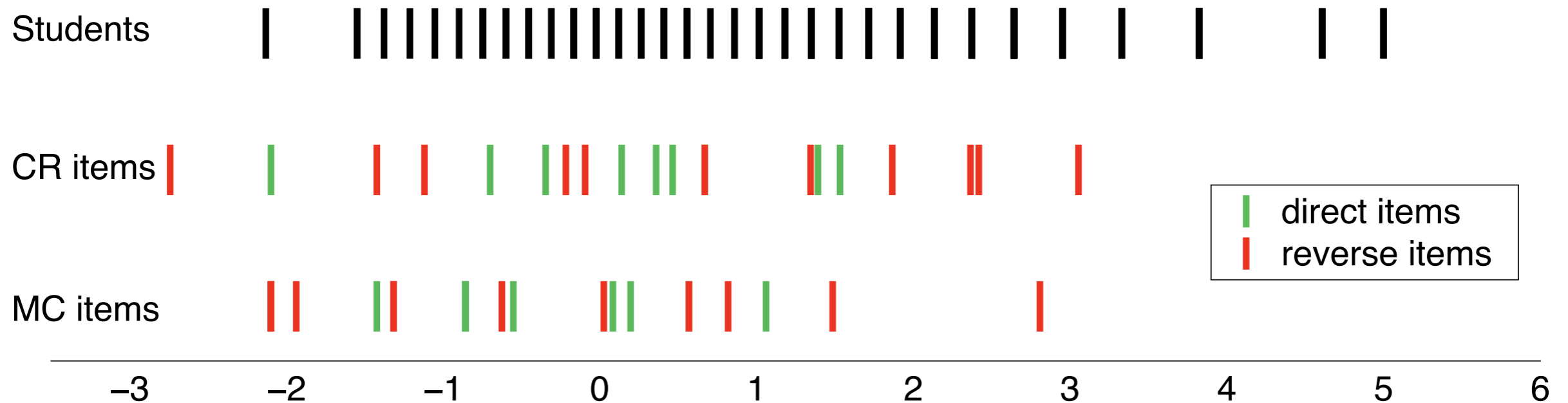
Format	Direction	Mean	SD
CR	Direct	0.16	1.11
CR	Reverse	0.56	1.84
MC	Direct	-0.43	1.00
MC	Reverse	-0.33	1.62

Items by format and direction



2 (format) × 2 (direction) within subjects ANOVA.

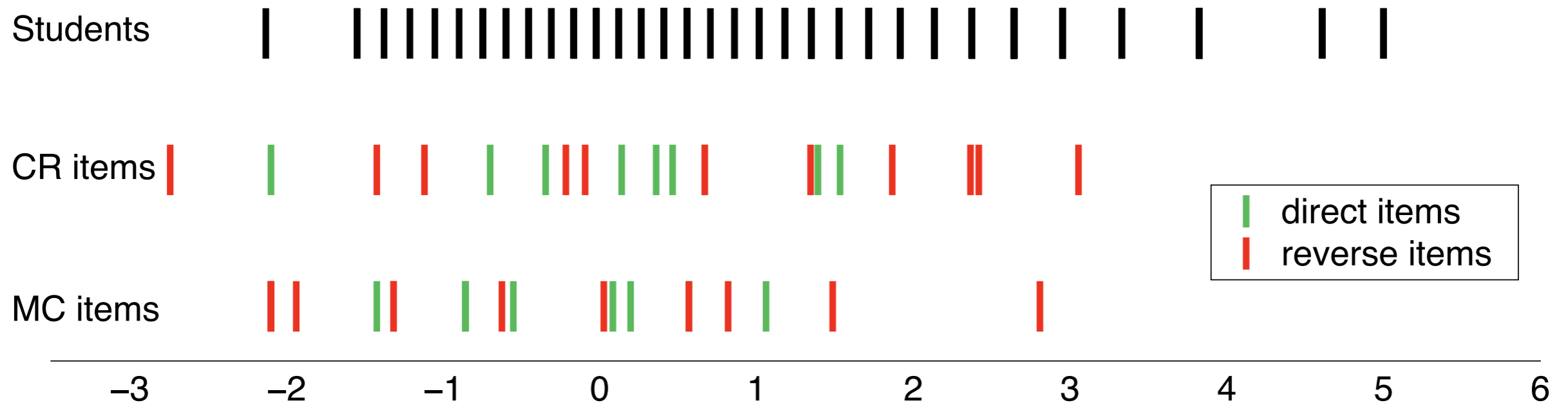
Items by format and direction



2 (format) × 2 (direction) within subjects ANOVA.

Main effect of format with CR harder than MC,
 $F(1, 115) = 102.37, p < .001, \eta^2 = .47.$

Items by format and direction

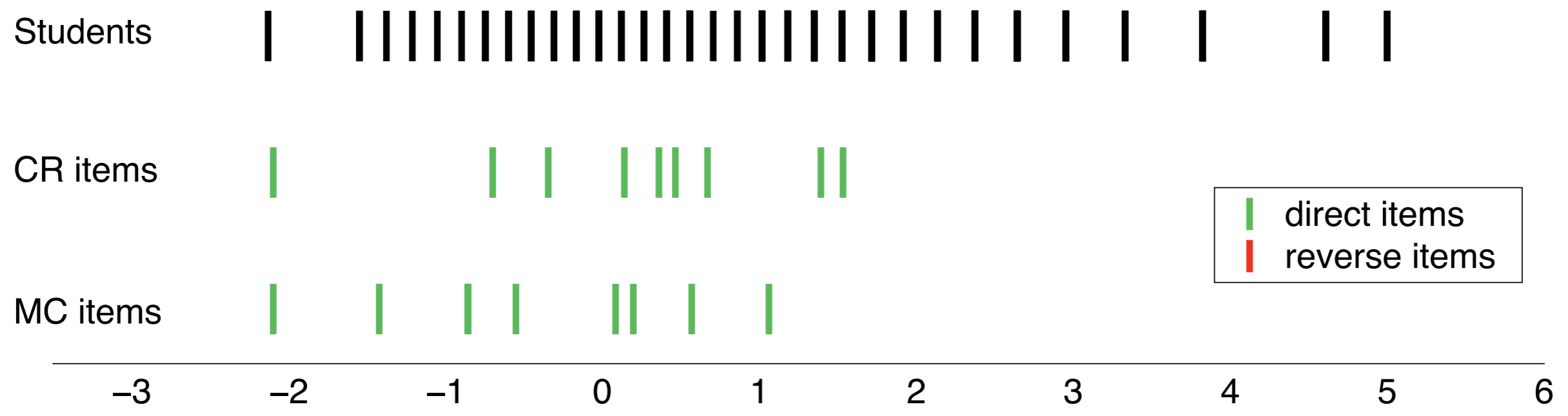


2 (format) \times 2 (direction) within subjects ANOVA.

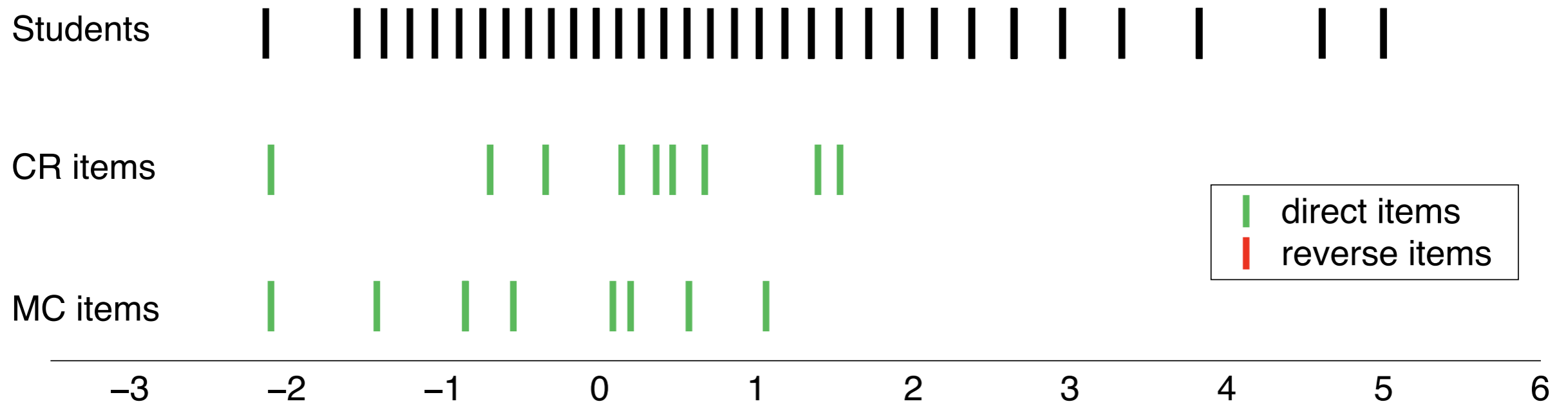
Main effect of format with CR harder than MC,
 $F(1, 115) = 102.37, p < .001, \eta^2 = .47.$

Significant format \times direction interaction,
 $F(1, 115) = 6.89, p = .010, \eta^2 = .06.$

Direct items across format



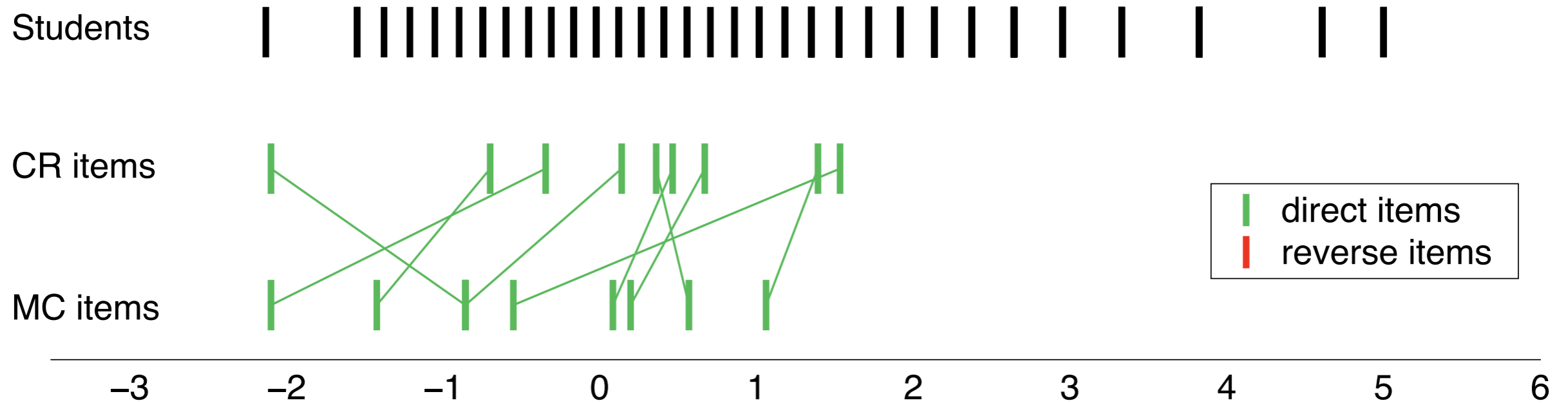
Direct items across format



Direct items more difficult in CR format,

$$t(115) = 5.46, p < .001 \text{ (paired).}$$

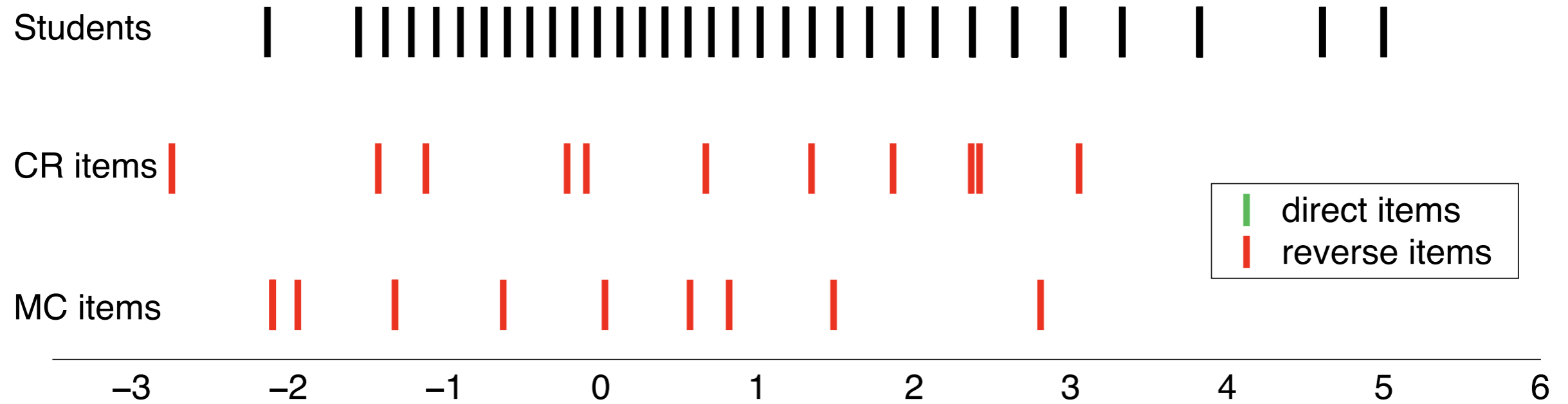
Direct items across format



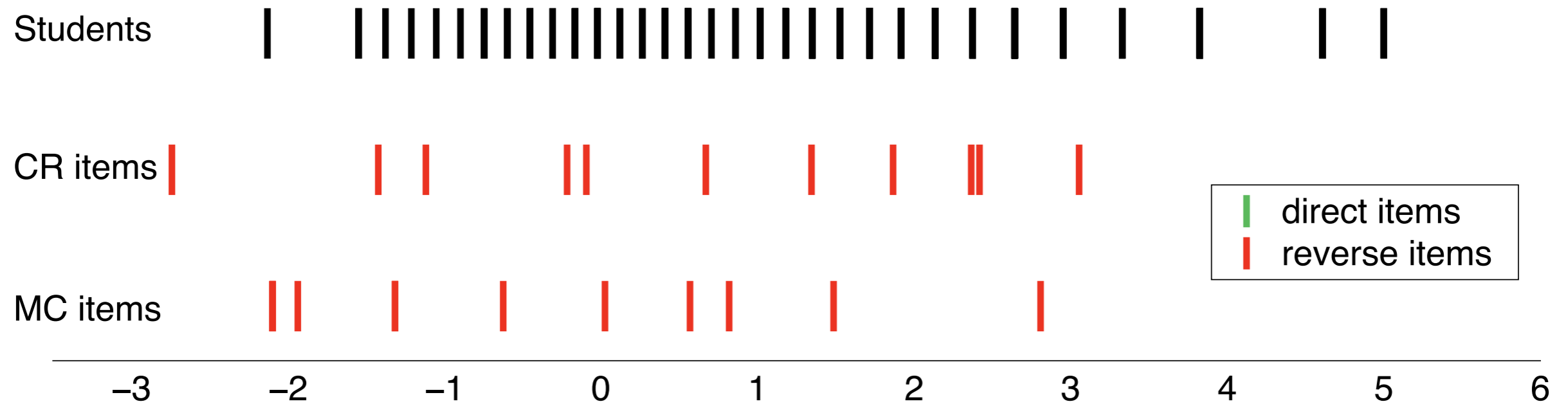
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Reverse items across format



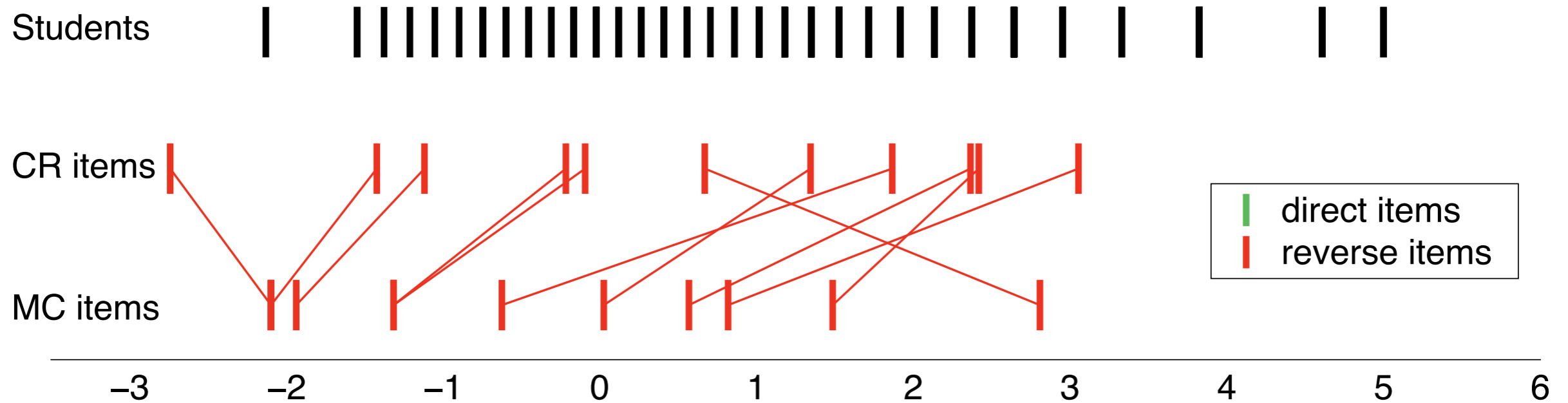
Reverse items across format



Reverse items more difficult in CR format,

$$t(115) = 10.01, p < .001 \text{ (paired).}$$

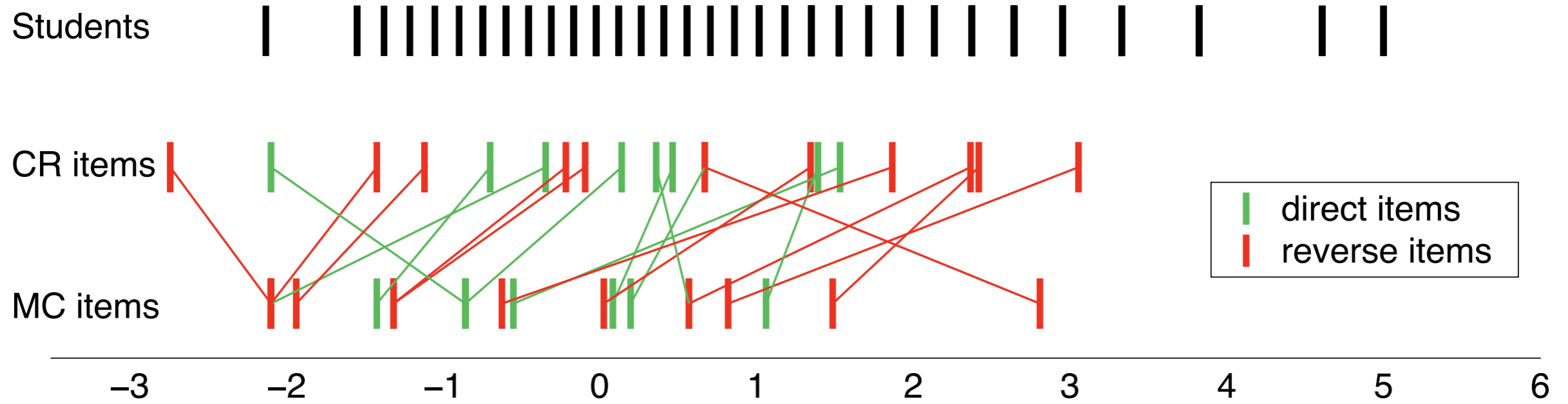
Reverse items across format



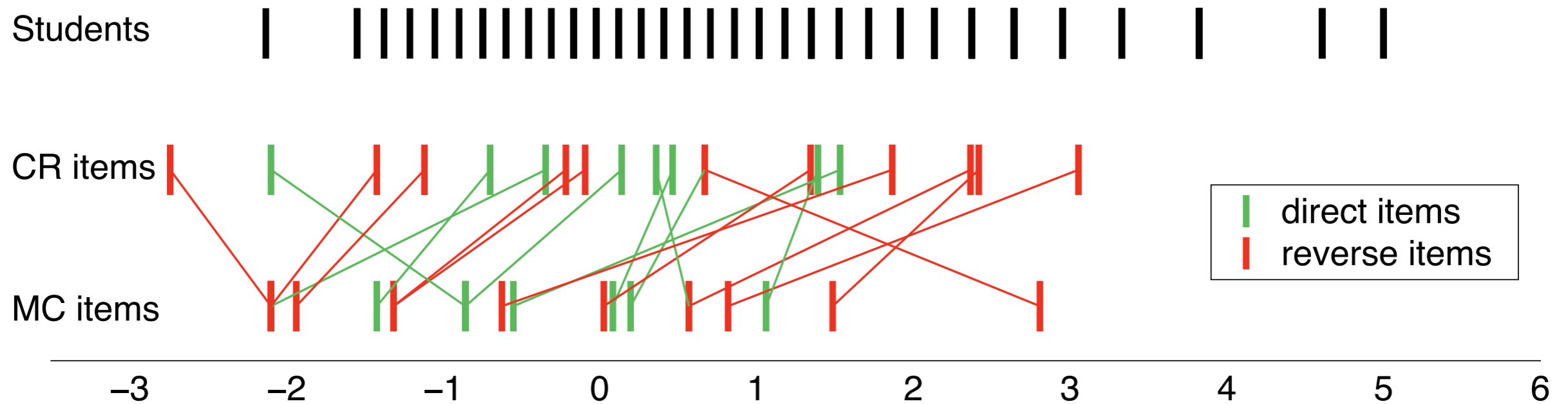
Reverse items more difficult in CR format,

$$t(115) = 10.01, p < .001 \text{ (paired).}$$

Is the difference greater for reverse items?



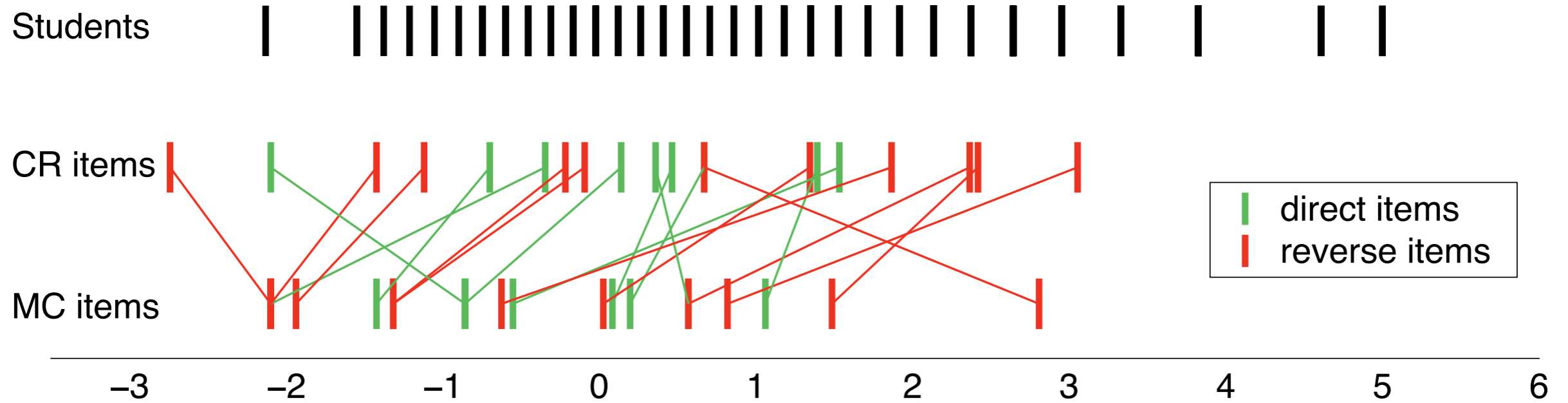
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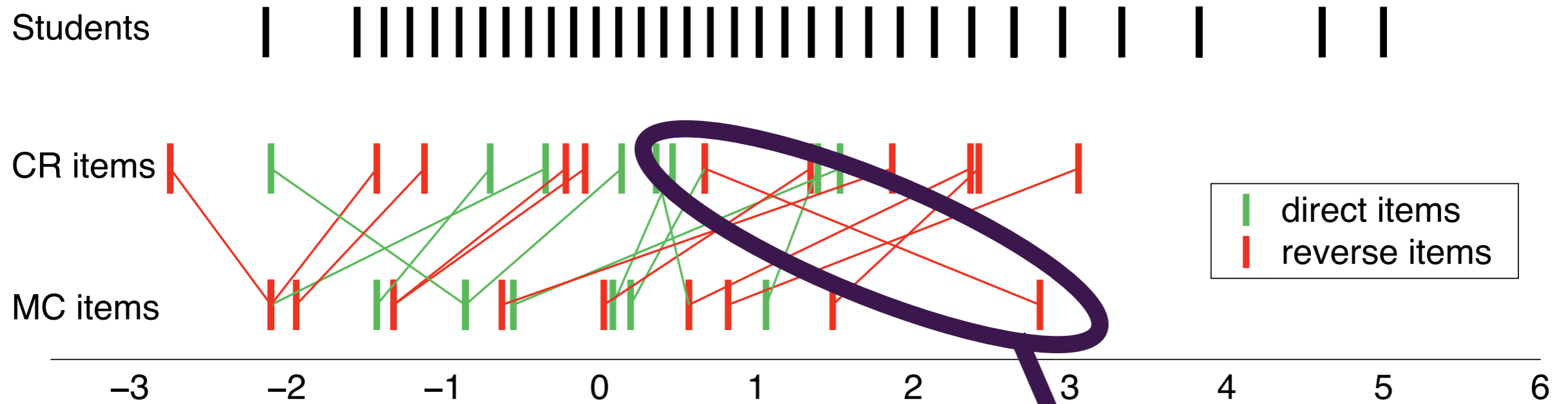
Direct: mean difference = 0.59, SD = 0.99.
Reverse: mean difference = 0.89, SD = 1.31.

Difference is greater for reverse items,
 $t(115) = -2.54, p = .012.$

Was every reverse item easier in MC?



Was every reverse item easier in MC?



What happened here?

Harder in MC format

What is the solution set: $2(x - 3) = 5x - 3(x + 2)$?

Select one:

- a.
{all real numbers}
- b.
{0}
- c.
{6}
- d.
{12}
- e. No solutions.

Solve for x in the equation $2 \cdot (x - 3) = 5 \cdot x - 3 \cdot (x + 3)$. Replace ? in the curly brackets with your solution.

{?}

Type in $\{\mathbb{R}\}$ if there is more than one solution, and $\{\}$ if there are no solutions.

Never use MC?

Never use MC?

Circle the number that is **not** a factor of 36

4

6

8

9

AQA, Foundation GCSE, June 2015

Never use MC?

9. If a function is always increasing, then what must be true about its derivative?
- (a) The derivative is never negative.
 - (b) The derivative is always positive.
 - (c) The derivative is sometimes positive.
 - (d) The derivative is negative.
 - (e) We can not conclude anything about the derivative.

Adapted from Epstein (2013).

Thank you

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Mathematics Education Centre