

## Task Difficulty and Task Sustainability

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Title on program: A method for estimating the subjective difficulty of different kinds of tasks and for relating subjective difficulties to task-order preferences:  
Speaking one language or another, and adding numbers or lifting objects

## Background

A challenge for psychonomic science is to identify a single, unified metric for task difficulty. So far, descriptions of task difficulty have been ad hoc. They have included the following:

Difficult tasks take more effort than easy tasks (e.g., Kahneman, 2011; Kool et al., 2010).

Difficult tasks need more external rewards than easy tasks (Westbrook & Braver, 2015).

Difficult tasks can be done by fewer individuals than easy tasks (Thurstone, 1927).

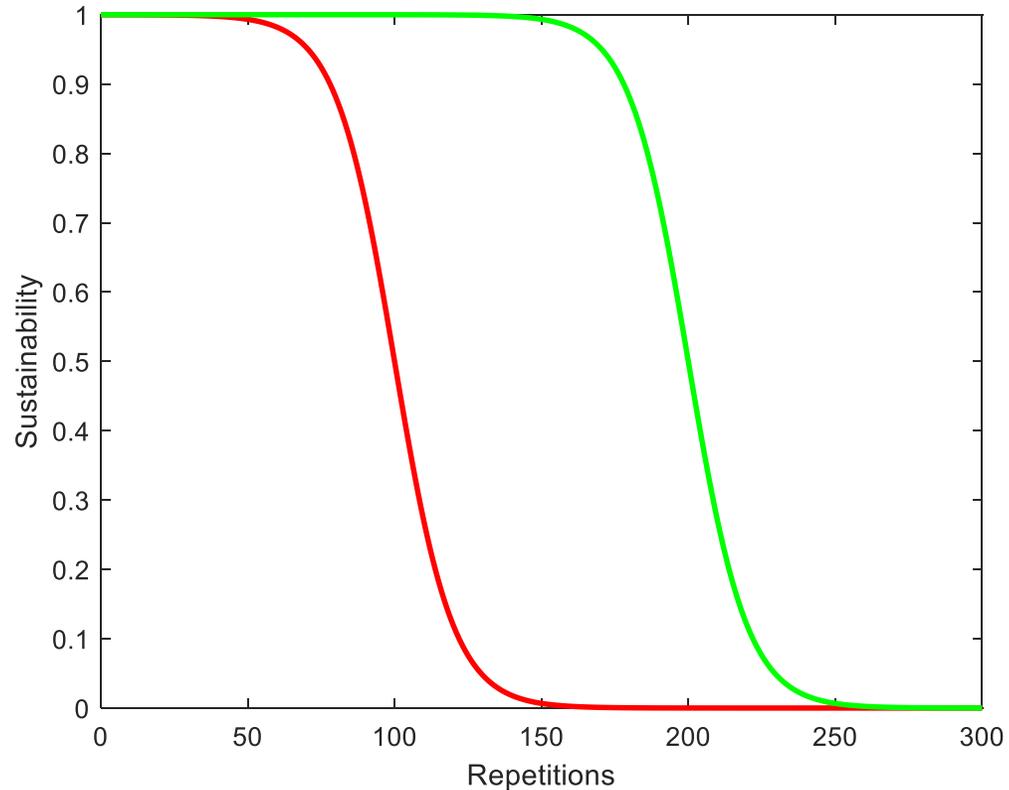
Difficult tasks cause more mistakes than easy tasks (e.g., Dunn et al., 2019).

Difficult tasks take more time than easy tasks (e.g., Rosenbaum & Bui, 2019; Gray et al., 2006).

Difficult tasks incur more opportunity costs than easy tasks (e.g., Kurzban et al., 2013).

All of these statements may be true in local contexts, but the challenge remains: Is there a unified metric for task difficulty? A hint that there might be one is that people can compare the difficulty of different kinds of tasks (Fegghi & Rosenbaum, 2019; Potts et al., 2018).

## Hypothesis: Ease (opposite of difficulty) may be sustainability

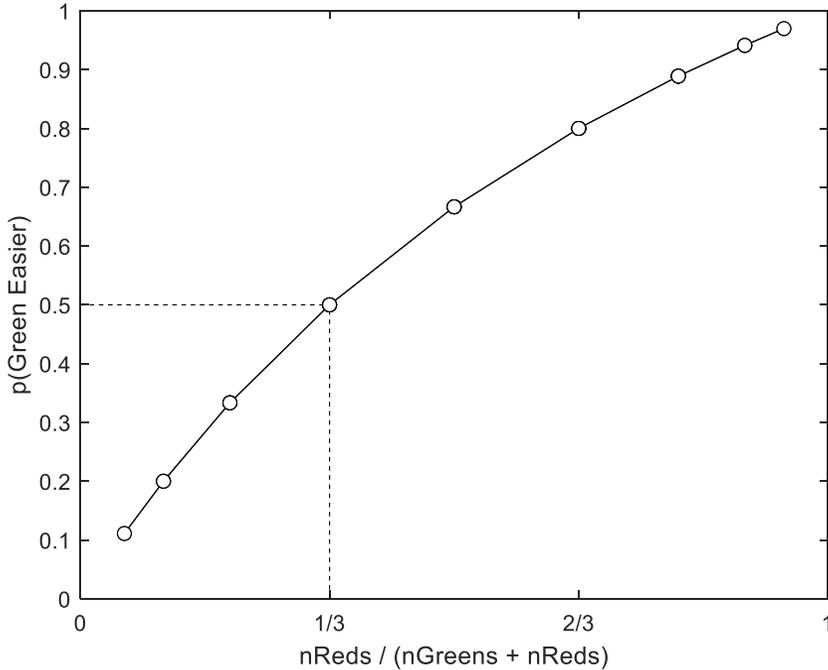


Example: The red (left) task is harder (less sustainable) than the green (right) task

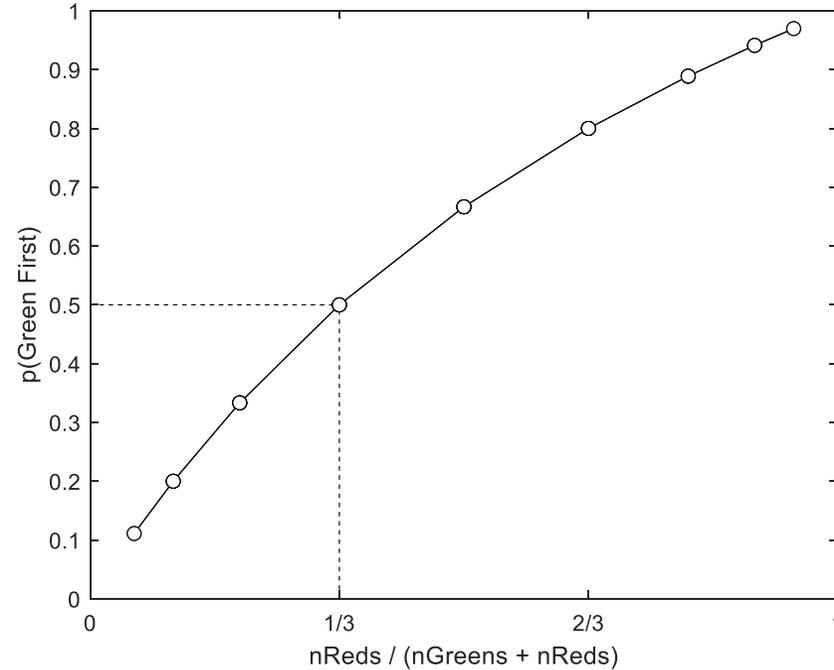
Further rationale for pursuing the sustainability hypothesis besides unified measure: Tiny differences in single productions can get magnified over many repetitions (actual or simulated). More samples will better approximate true ease.

# Predictions

Which-is-easier judgments should reflect relative sustainability

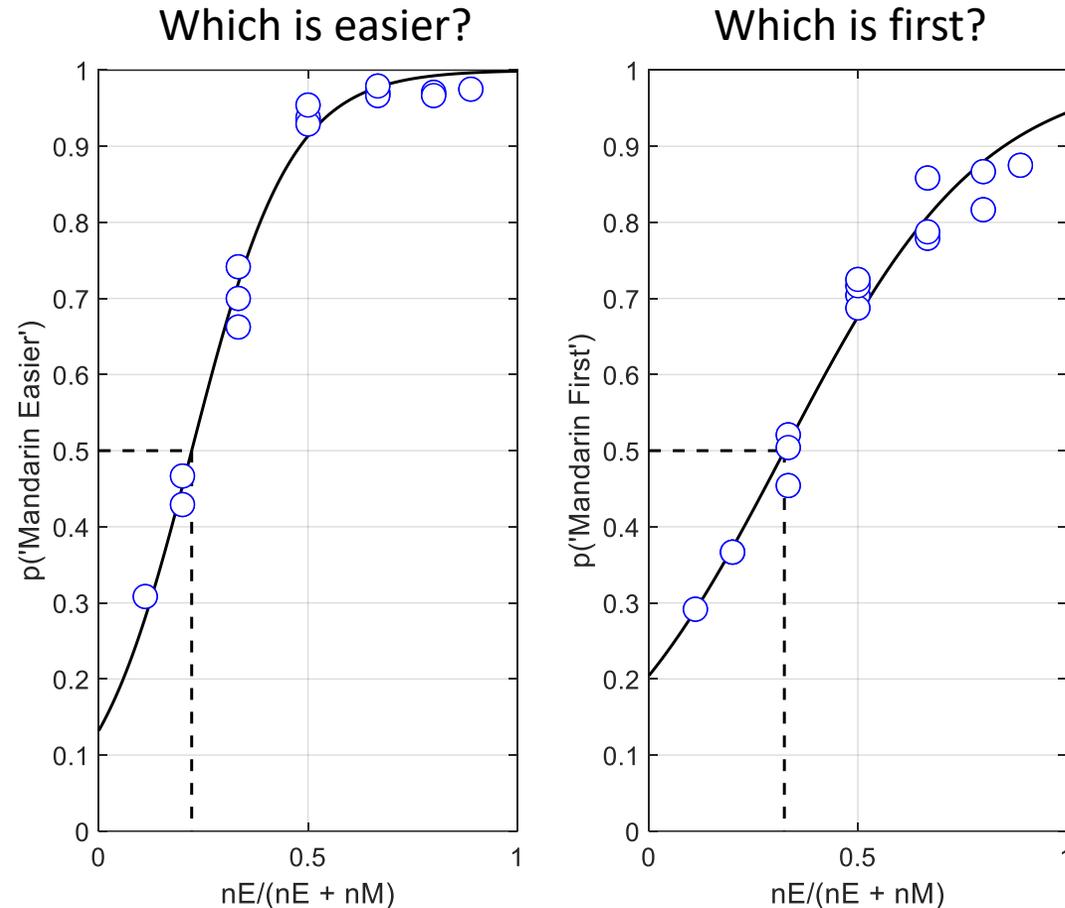


Which-is-first judgments should also reflect relative sustainability



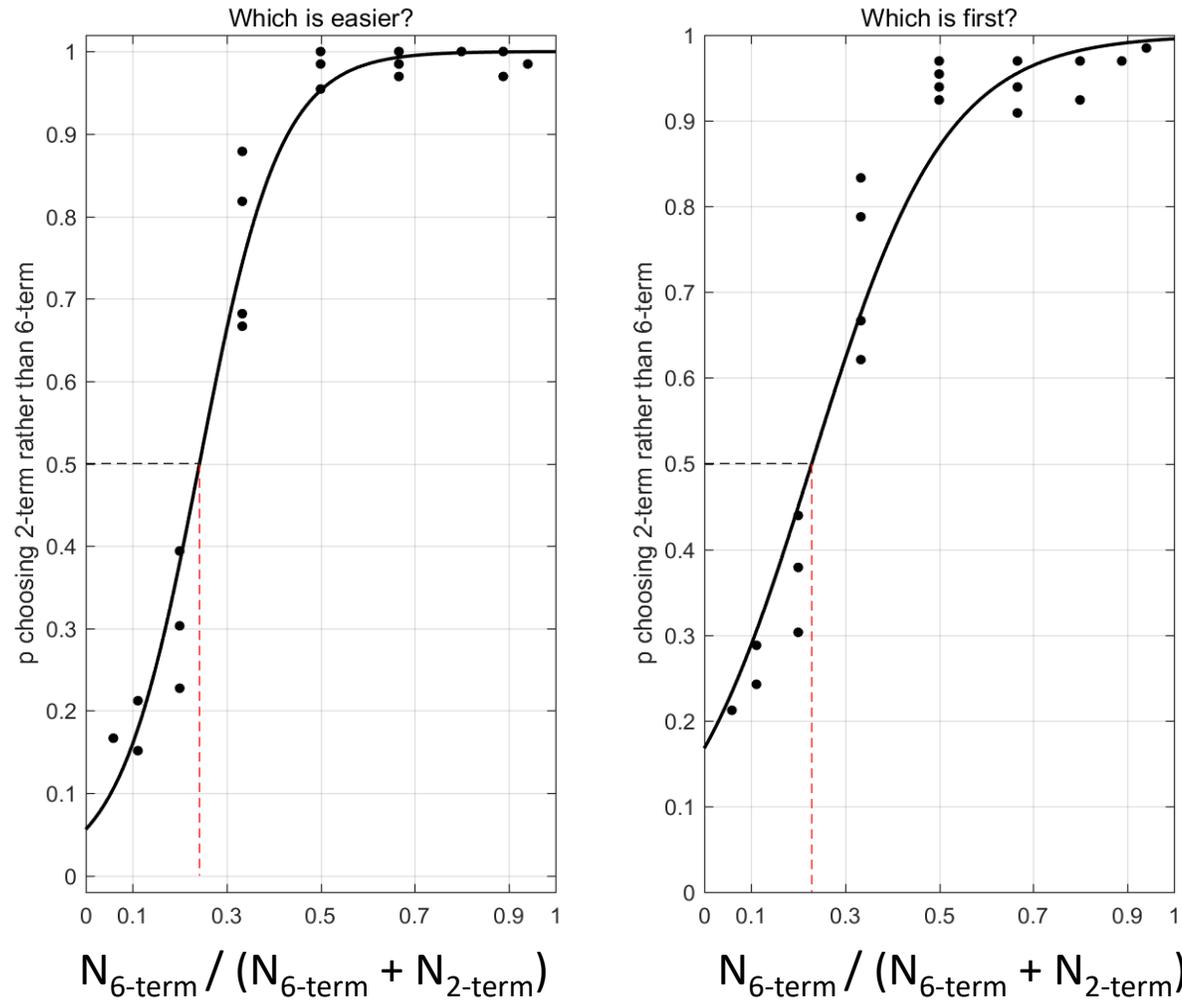
x-axis values are based on possible values of nReds and nGreens = [5 10 20 40 80]. y-axis values are based on the same terms but with each term divided by that task's "half life" (100 for red and 200 for green). By plotting ratios rather than differences on the x axis you can make a statement like "The Green task is 2 times easier than the green task." Statement based on the fact that the point of subjective equality (PSE) is 1/3 (i.e., doing 2 green tasks has the same difficulty as doing 1 red task).

# Naming Pictures in Mandarin (L1) or English (L2)



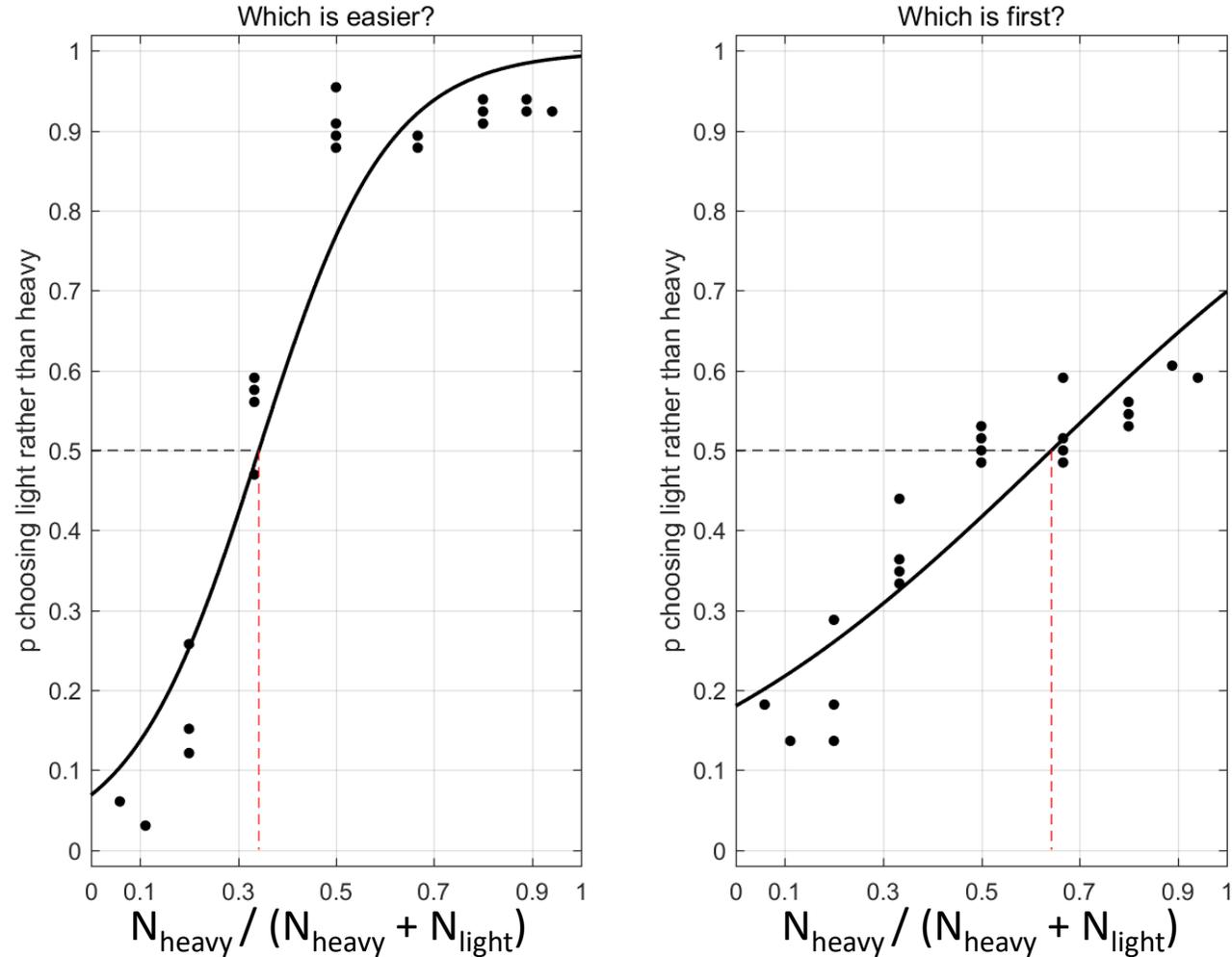
120 native-Chinese students at Beijing Normal University made which-is-easier judgments [left panel] and which-is-first judgments [right panel] for 10, 20, 40, or 80 possible pictures in Mandarin versus 10, 20, 40, or 80 possible pictures in English. Mandarin was about 4 times easier than English for these participants.

# Solving 6-term or 2-term Arithmetic Problems



22 students at UC Riverside made which-is-easier judgments [left panel] and which-is-first judgments [right panel] for 5, 10, 20, 40, and 80 possible math problems with 6 terms (e.g.,  $8-9+2-9+6-1 = ?$ ) versus 2-terms (e.g.,  $8-9 = ?$ ). 2-term problems were about 3 times easier than 6-term problems for these participants.

# Moving A Heavy Bucket or An Empty Bucket

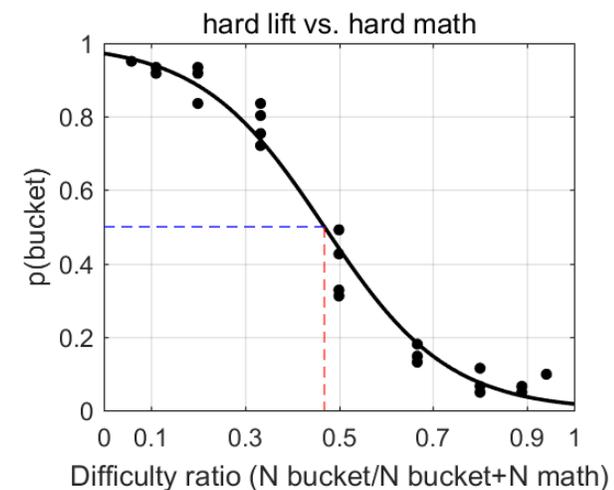
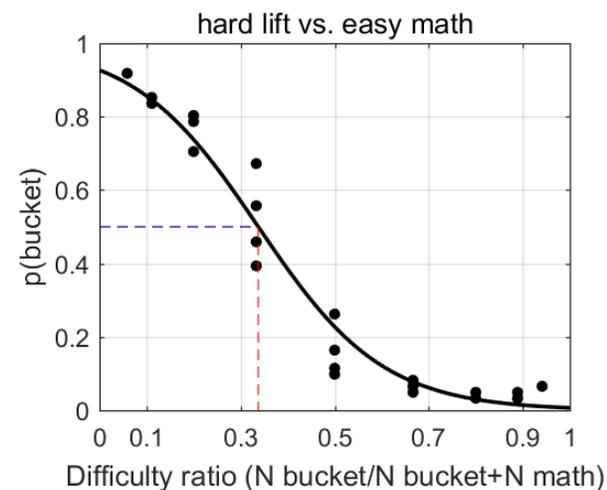
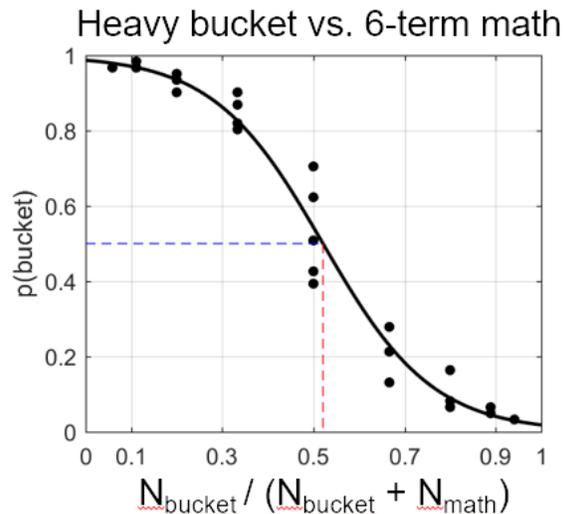
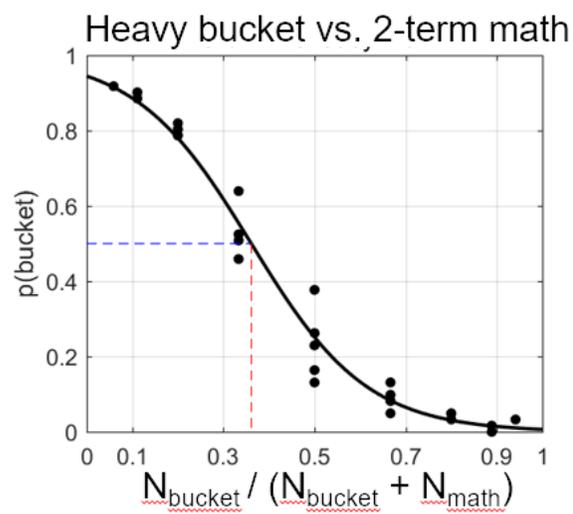
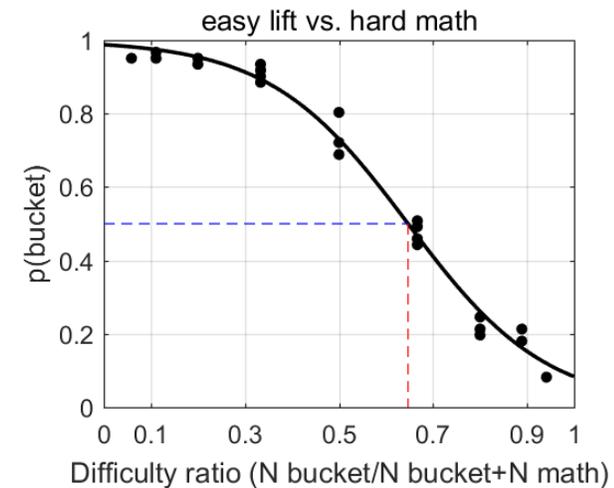
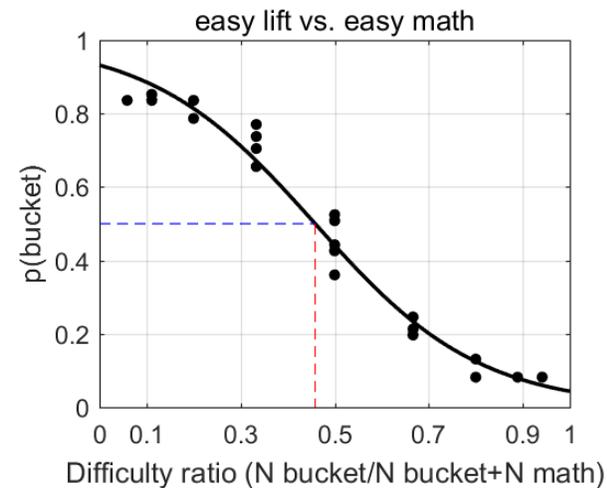
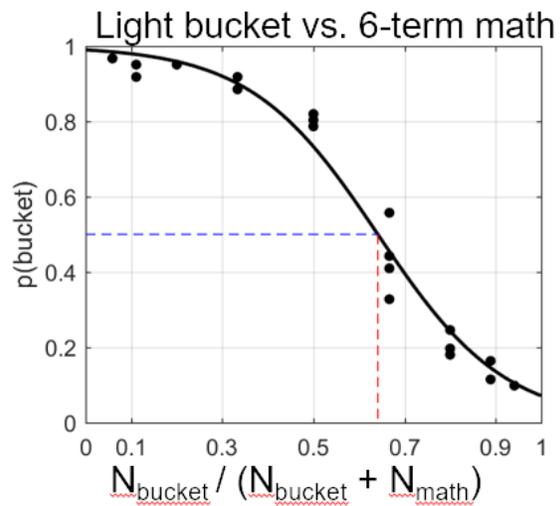
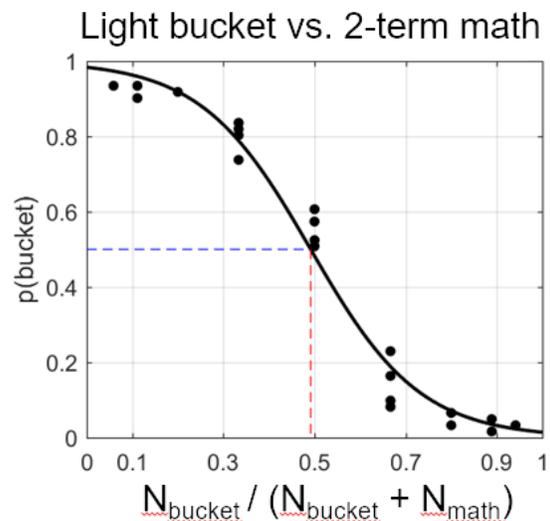


16 students at UC Riverside made which-is-easier judgments [left panel] and which-is-first judgments [right panel] for moving an empty bucket 5, 10, 20, 40, or 80 times back and forth between two sides of a 3-foot wide table versus moving the same 5, 10, 20, 40, or 80 times back and forth over the same distance with a 7 pound loaded bucket. Light bucket moves were about 2 times easier than heavy bucket moves for these participants.

# Buckets versus Math

Which is easier?

Which is first?



16 students at UC Riverside made which-is-easier judgments [left panels] and which-is-first judgments [right panels] for the math and bucket-move tasks.

## Conclusions

Task sustainability provides a unified metric for task difficulty.

Consistent with the sustainability hypothesis, which-is-easier judgments varied with number of proposed task repetitions at different rates for different tasks.

Also consistent with the sustainability hypothesis, which-is-first judgments varied with number of proposed task repetitions much as which-is-easier judgments did.

And also consistent with the sustainability hypothesis, participants could compare the difficulty of bucket tasks and math tasks.

The approach presented here allows for the quantitative estimation of the subjective of difficulty of different tasks. (Just asking participants to rate difficulty has proven to be much less sensitive in other work.)

# References

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