

Proportional Reasoning Across Formats

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Author Note

The authors made the following contributions. Albert Sebastian: Conceptualization, Data Analysis, Writing - Original Draft Preparation.

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## Abstract

Comparing proportions is a fundamental cognitive skill demonstrated across human development. This study examines how well adults compare proportions when presented in different visual formats. Here we show that performance varies significantly across formats, with integrated formats leading to higher accuracy. These results highlight the role of visual integration in proportional reasoning, advancing our understanding of how humans process comparative proportions. This study further demonstrates a positive correlation between reaction time and accuracy, providing insights into decision-making processes in perceptual tasks.

*Keywords:* proportional reasoning, visual formats, cognitive science

Word count: X

## Proportional Reasoning Across Formats

**Introduction**

Comparing proportions is a fundamental cognitive skill seen in infants and adults alike. However, the ability to do so can be influenced by how proportions are presented. Visual integration and congruency play critical roles in making accurate judgments. This study seeks to explore the impact of presentation formats and numerator congruency on proportional reasoning, with the following objectives:

1. Does average performance vary across format type?
2. Does average performance vary across numerator congruency status?
3. Does numerator congruency vary across format type? (i.e., is there an interaction)

This investigation expands on prior work by examining the relationship between reaction time and accuracy, providing new insights into decision-making processes in proportional reasoning tasks.

**Methods**

A total of 99 adults participated in the study.

First, participants were introduced to a story about a magic ball and that the outcome (i.e., blue or orange) depended on the proportions. They were then asked to compare the proportions of different images. In other words, participants were shown two images of the same kind at the same time and asked to decide which had a higher proportion of the shape (or dots) colored in blue.

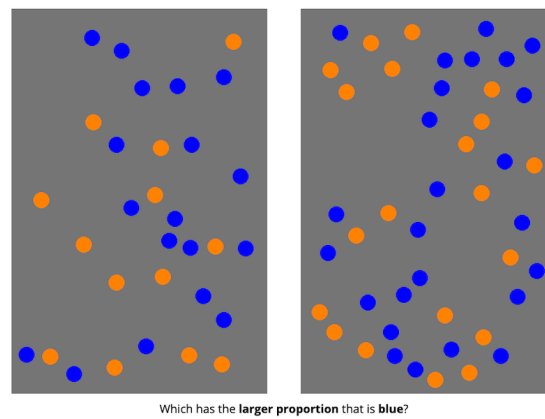


Figure 1. Illustration of Probtask trials.

#### Condition

What is not shown in figure 1, is that there were four different conditions that changed what kinds of images the participants saw:

- divided blobs: blue and orange were entirely separate
- integrated blob: one blob, divided to be part blue and part orange
- separated dots: blue and orange dots were on opposite sides of the image
- integrated dots: blue and orange dots were intermixed

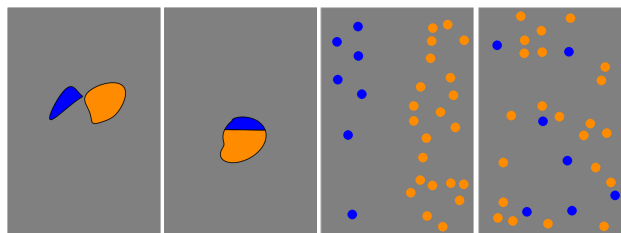


Figure 2. Illustration of Probtask formats.

Note: The conditions in figure 2 are named as follows(from left to right):Divided Blob, Integrated Blob,Separated Dots, and Integrated Dots

**Data analysis.** We used R [Version 4.4.1; @] and the R-packages *ggdist* (Version 3.3.2; Kay, 2024), *ggplot2* (Version 3.5.1; Wickham, 2016), *papaja* (Version 0.1.3; Aust & Barth, 2024) and *tidyverse* (Version 2.0.0; Wickham et al., 2019) for all our analyses.

Results

- Does average performance vary across format type, ignoring all other aspects of the stimuli?

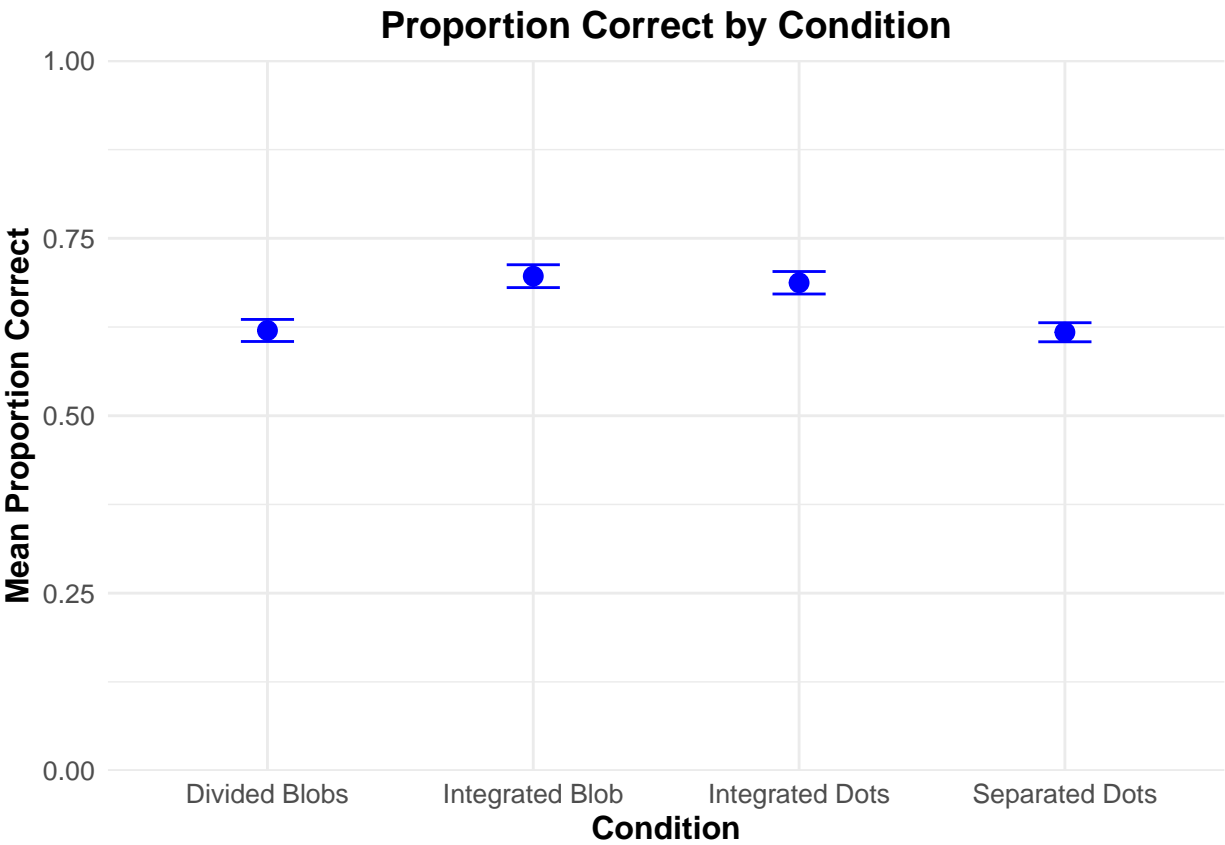


Figure 3. Average performance by format type

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2. How are reaction time and accuracy related?

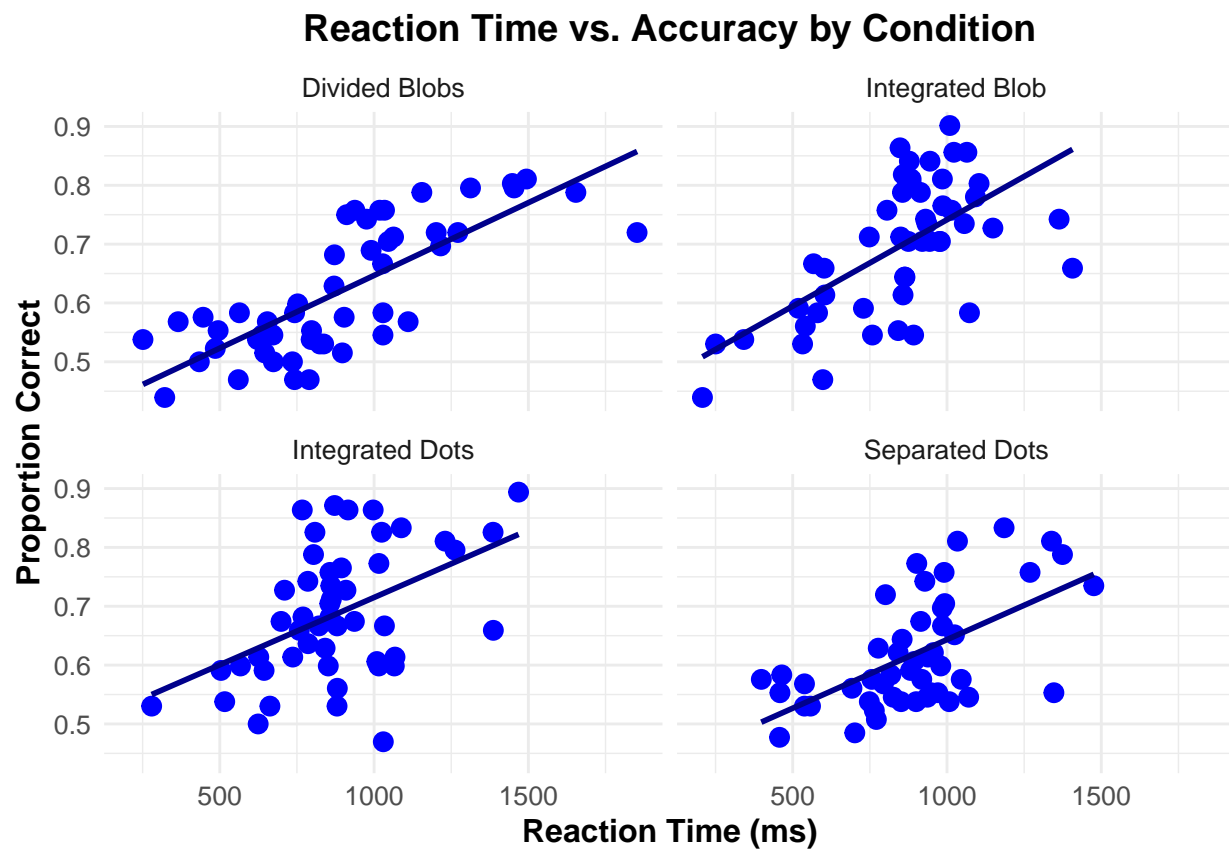


Figure 4. Reaction time and accuracy relation

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### 3. How does numerator congruency interact with format type?

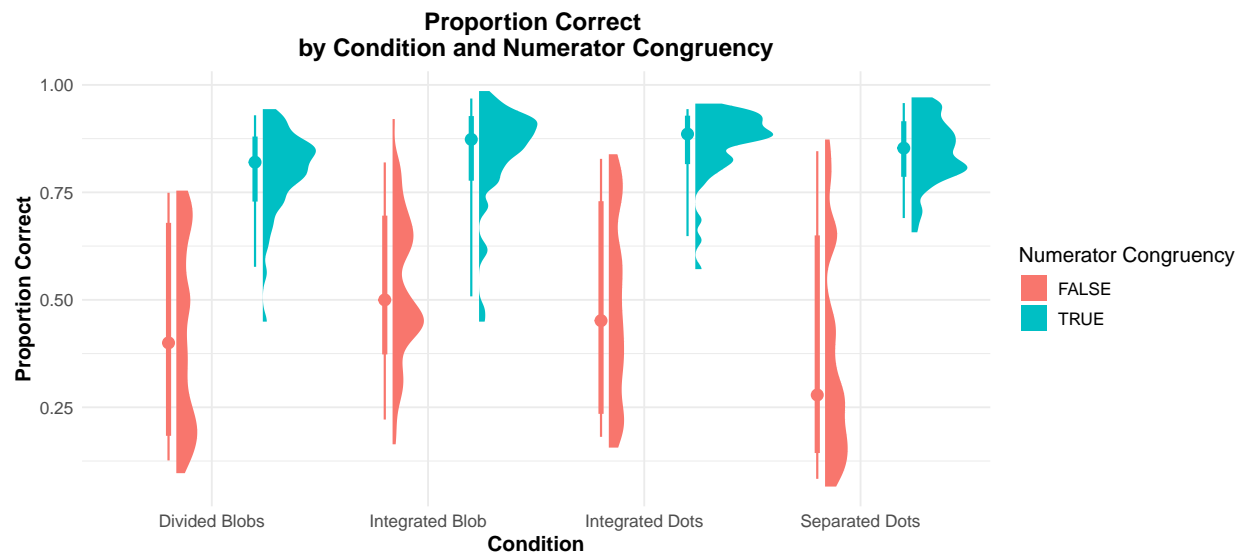


Figure 5. How numerator congruency interacts with format type

## Discussion

As per figure 3, participants' average performance was at its best with the integrated blob and dots and was at its worst with the separated/divided blobs and dots.

As shown in figure 4, for all conditions, as reaction time increases, accuracy increases as well

As per figure 5, when there is a numerator congruency, the proportion correct across all format types is higher than when there is not.

1. The most annoying part of this assignment was integrating the old plots into this poster and having to make the adjustments in order to make them "publication" ready
2. The most satisfying part of this assignment is when you make aesthetic changes on the file and then rendering it to see how much better it makes the poster.



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