Directly Encoding Relations Improves Data Pair Relation Perception

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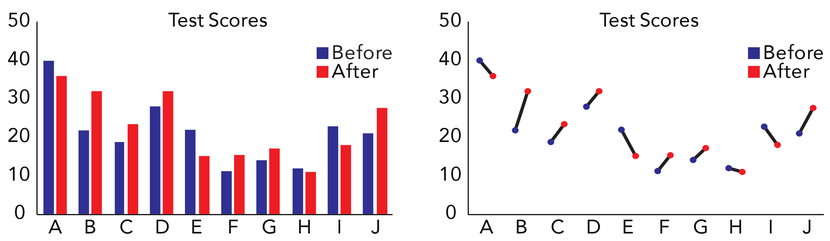
ENCODING RELATIONSHIPS

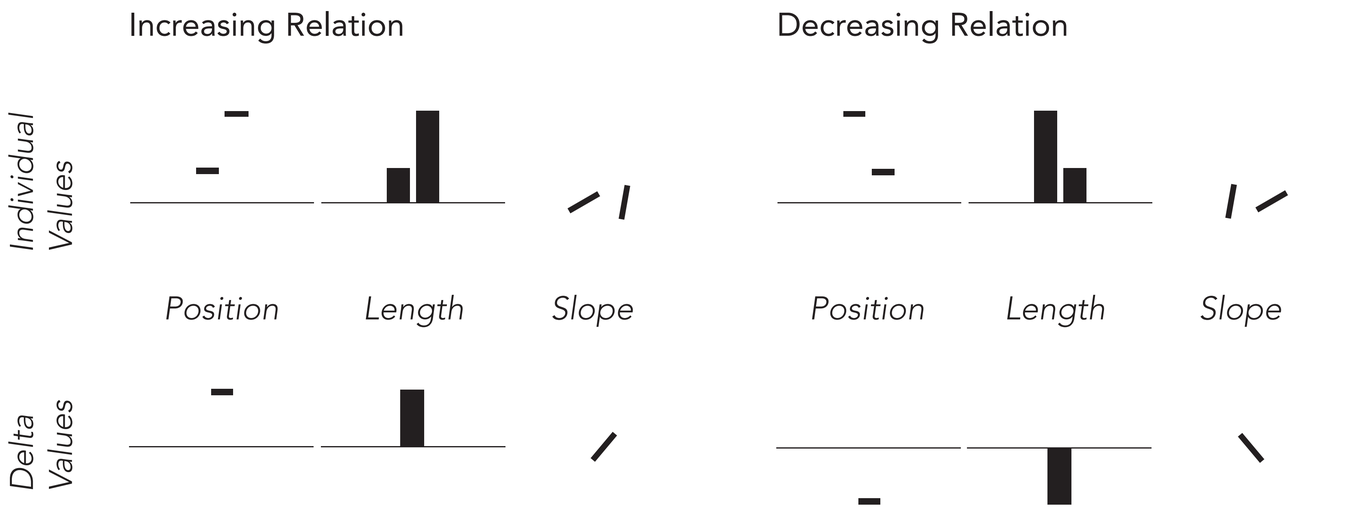


It is much harder to perceive differences in relationships between multiple objects (e.g., +– among –+ 's) than differences in simple visual features (e.g., a / among \ 's) (Wolfe, 1998).

How can we efficiently perceive **relations** in data sets?

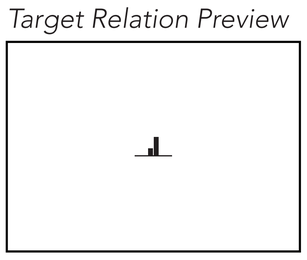
Should data be depicted as **individual data points** or as single visual features representing **deltas** for efficient relation perception?

ENCODINGS

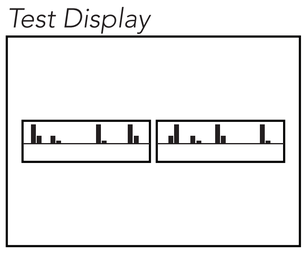


EXPERIMENT 1: FINDING A UNIQUE RELATION

Target Relation Preview



Test Display



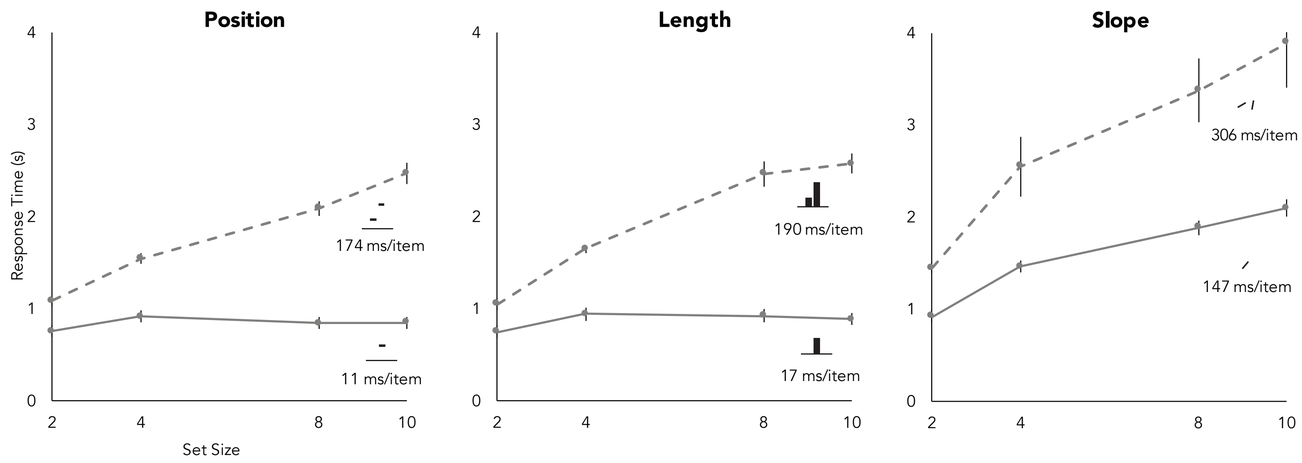
We constructed a task designed to model situations in which observers search for a particular data relation.

Q: Which box contains the target relation?

Conditions:
Values Encoded (individual values, delta values)
Feature (position, length, slope)
Set Size (2, 4, 8, 10)

If relations depicted as single visual features representing deltas leads to more efficient processing, then:

Delta Values Response Time < **Individual Values Response Time**

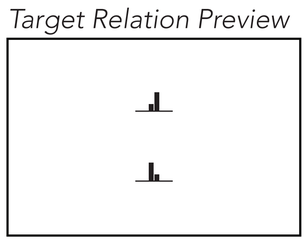


Visual search for a particular relation is faster when relations are directly encoded by **single visual features** than as individual data values.

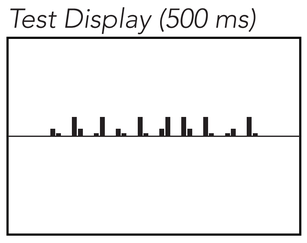
Note: Error rates were low (M = 6%), with no error / response time trade-off.

EXPERIMENT 2: AGGREGATING THE PROPORTION OF RELATIONS

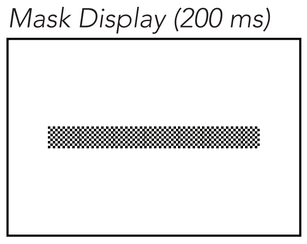
Target Relation Preview



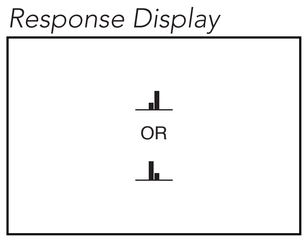
Test Display (500 ms)



Mask Display (200 ms)



Response Display



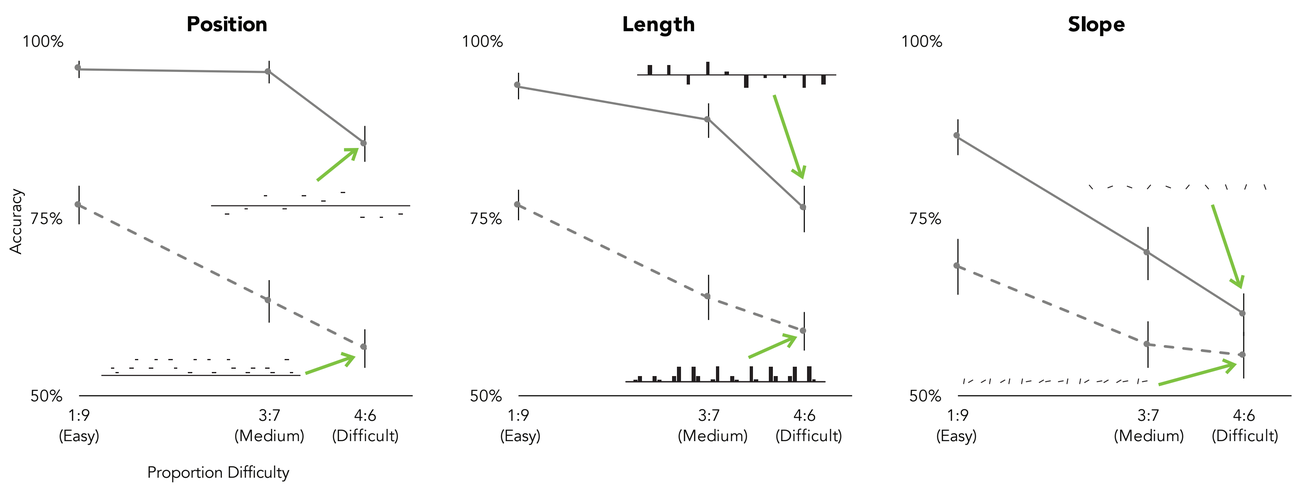
We constructed a task designed to model situations in which observers judge the proportion of relations (e.g., is there general improvement?).

Q: Which relation is there more of within the display?

Conditions:
Values Encoded (individual values, delta values)
Feature (position, length, slope)
Proportion Difficulty (1:9, 3:7, 4:6)

If relations depicted as single visual features representing delta values leads to more efficient processing, then:

Delta Values Accuracy > **Individual Values Accuracy**



Aggregation of proportions of relations is more accurate when relations are directly encoded by **single visual features** than as individual data values.

CONCLUSION

Suggests **~74% faster** visual search for a particular relation and **~30% more accurate** judgment of proportions of relations when those relations are encoded as **single visual features** rather than as individual data values.

Even in a well-designed visualization, extracting relations among data values requires visual comparisons that are extremely slow. Explicitly encoding those relations, as in a slopegraph, can drop visual processing costs by an order of magnitude.

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