

# Analytic and non-analytic processes: Classification in adult humans

Andy Wills

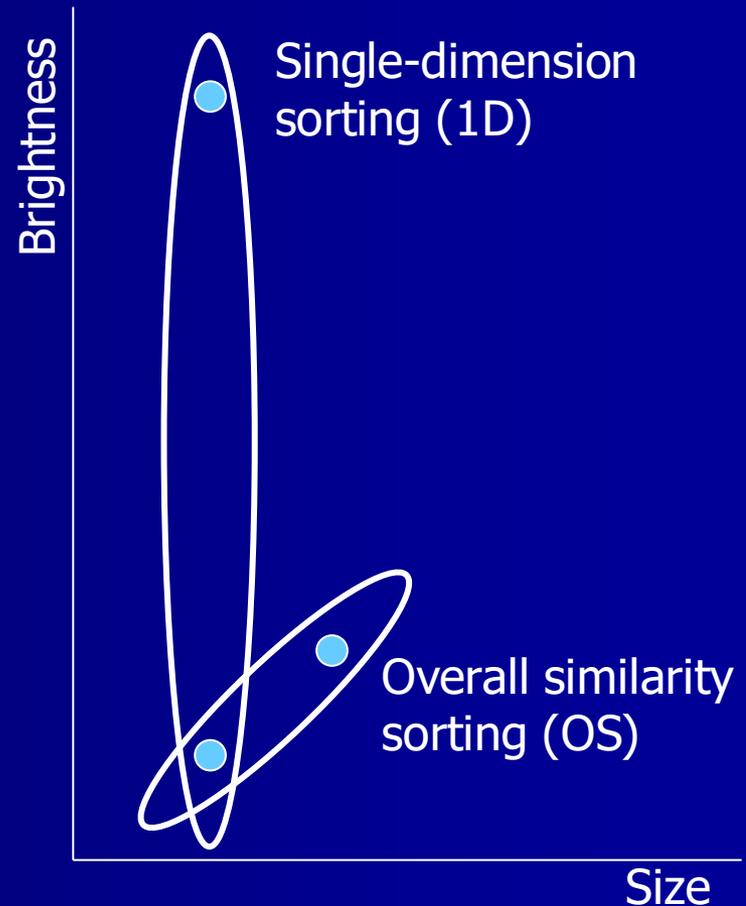
Fraser Milton, Chris Longmore



# “The child in all of us”

(Smith & Kemler Nelson, 1984)

- Adults sort predominately on the basis of a single dimension (analytic, rule-based)
- Children, and adults under time pressure, sort on the basis of overall similarity (non-analytic, similarity-based, “associative”)

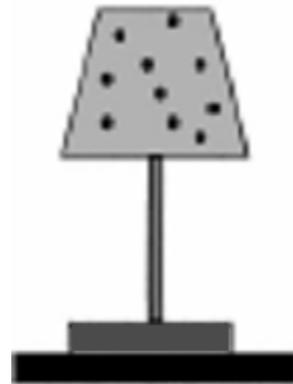
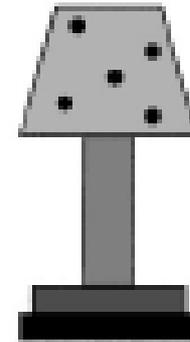
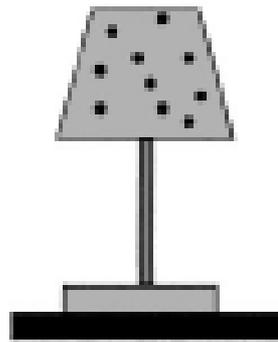


# Status of overall similarity sorting

- Smith and Kemler Nelson (1984) is typical of the general characterisation of overall similarity sorting as non-analytic.
- Recent work on the match-to-standards procedure suggests this characterisation is too simple.

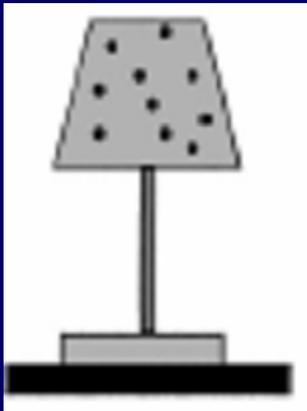
# Milton & Wills (2004)

(Regehr & Brooks, 1995)



# OS and UD sorting

1 1 1 1



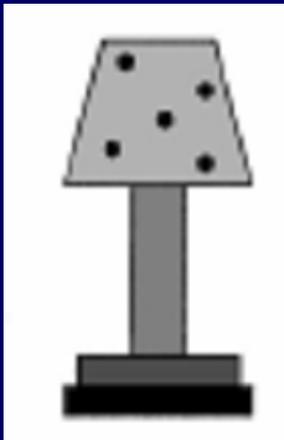
Overall similarity

1 1 1 1  
0 1 1 1  
1 0 1 1  
1 1 0 1  
1 1 1 0

Unidimensional

1 1 1 1  
1 0 0 0  
1 0 1 1  
1 1 0 1  
1 1 1 0

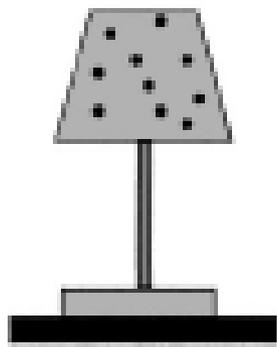
0 0 0 0



0 0 0 0  
1 0 0 0  
0 1 0 0  
0 0 1 0  
0 0 0 1

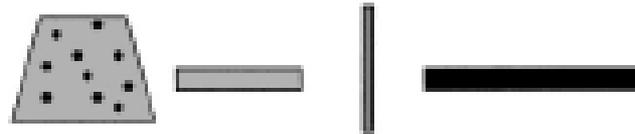
0 0 0 0  
0 1 1 1  
0 1 0 0  
0 0 1 0  
0 0 0 1

# Spatial integration effect (Milton & Wills, 2004)



Spatially integrated

OS	9
UD	9



Spatially separate

OS	13
UD	5

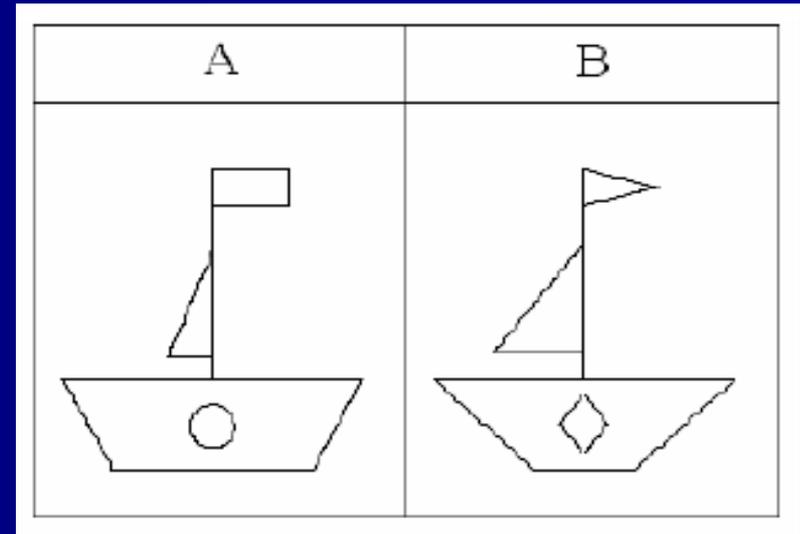
- Opposite to expectations under a “natural-ness” hypothesis
- Opposite to expectations under an integral/separable hypothesis
- Consistent with the idea that dimensional separation promotes a *dimensional summation* strategy – an analytic process that produces overall similarity sorting.
- Overall similarity sorting can be an analytic process?

# Overall similarity sorting can be analytic?

- If so, we should be able to see a reversal of classic triad task manipulations.
- Time pressure
  - Time pressure *increases* OS sorting
  - We should be able to show time pressure *decreasing* OS sorting.
- Concurrent load
  - Concurrent task load *increases* OS sorting
  - We should be able to show concurrent load *decreasing* OS sorting
- Instructional manipulations
  - Non-analytic instructions *decrease* UD sorting
  - We should be able to show analytic instructions *decreasing* OS sorting
- Impulsivity
  - Impulsive people are more likely to produce OS sorts.
  - We should be able to show that impulsive people are more likely to produce UD sorts.
- Working memory capacity
  - We would also predict OS sorters have a higher working memory capacity

# Time pressure

- Presentation time manipulation
- Each participant sorts 12 sets at one time pressure.



1 second

2.14 OS sorts

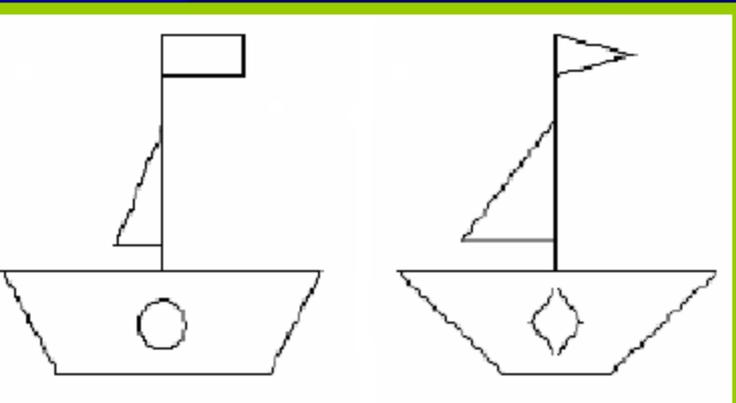
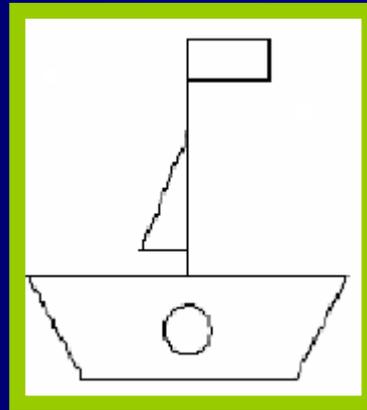
4 seconds

6.93 OS sorts

# Concurrent digit load

9

A or B?



"6 .. 4 .. 9 .. 2 .. 8 .. 1"

Load 2.1 OS

Control 5.4 OS

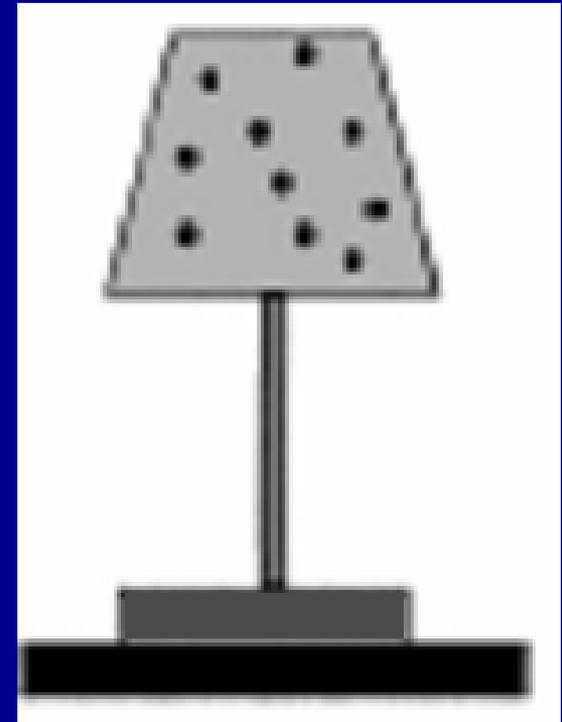
# Instructional manipulation

Standard instructions

- 3.1 OS

Analytic instructions

- 5.9 OS



# Working memory capacity

- Lampshade stimuli again; this time only sort one set (first sort is where WM demands are likely to be highest).
- “Operation span”
  - Standard measure of working memory
  - Solve equations
  - Each equation is accompanied by a word
  - Recall words in order at the end.
  - Working memory capacity indexed by maximum number of words recalled correctly (span)
- OS sorters *op span* = 3.7
- UD sorters *op span* = 2.4

# Impulsivity

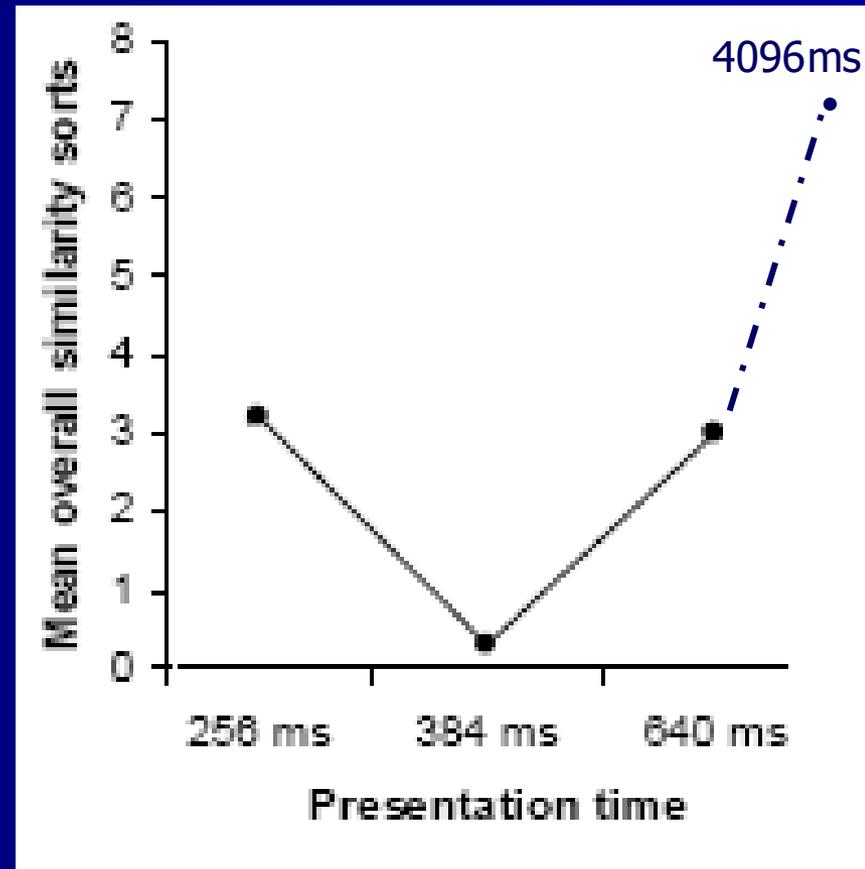
- Lampshades again.
- Standard impulsivity questionnaire administered at end of experiment.
- Median split of participants on impulsivity score.
- High impulsivity leads to significantly lower proportion of OS sorting.

# Analytic OS sorting

- Overall similarity sorting clearly can be the result of an analytic process.
- What underlies the difference between our tasks, and the triad task results?
  - Difference in procedure ?
  - Difference in severity of manipulations ?
- This is what we're currently working on, but here's a taster...

# Non-monotonic time pressure effects

- Mild-to-moderate time pressure *decreases* OS sorting.
- More severe time pressure *increases* OS sorting.
- OS sorting can be the product of both analytic and non-analytic processes.



# Conclusion / cautionary note

- Overall similarity sorting is typically seen as non-analytic / “associative”; single-dimension sorting is typically seen as analytic / rule-based.
- Such a view is well-supported, and we “buy” those arguments i.e. no suggestion here that previous results are artifactual.
- Nevertheless, we have strong converging evidence that overall similarity sorting can in fact be more analytic than single-dimension sorting, so...
- ... this is a cautionary tale for anyone who might wish to use type of classification strategy (e.g. UD vs. OS) as an index of the underlying cognitive processes.