

# Combination or Differentiation?

## Two theories of processing order in classification

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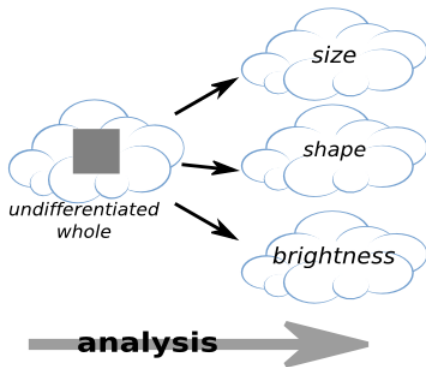
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9 Jan 2015



# Differentiation Theory

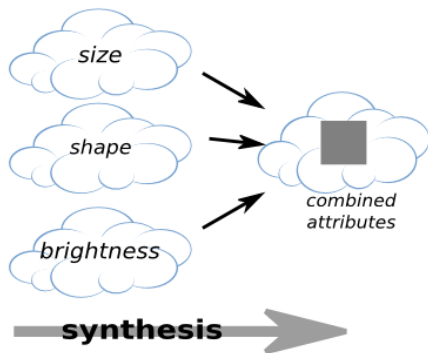
Classification starts with an undifferentiated whole, which can be broken down into its constituent attributes if time and cognitive resources allow.



e.g. Lockhead, 1972; Brooks, 1978; Ward, 1983; Kemler Nelson, 1984; J. Smith & Kemler Nelson, 1984; Ashby et al., 1998; E. Smith et al., 1998; Goldstone & Barsalou, 1998; Tracy et al., 2003; Couchman et al., 2010.

# Combination Theory

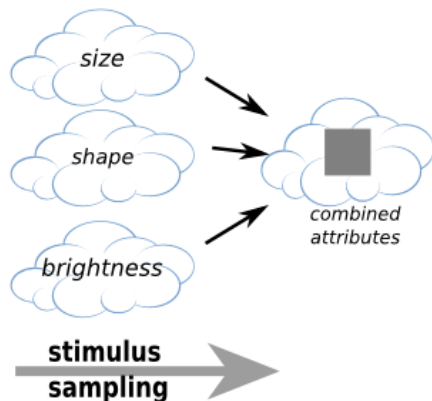
Classification starts with the attributes. Information from these attributes can be combined if time and cognitive resources allow.



e.g. Oden & Massaro (1978); Treisman & Gelade (1980); Lamberts (1995); Milton & Wills (2004).

# Instantiating the theories

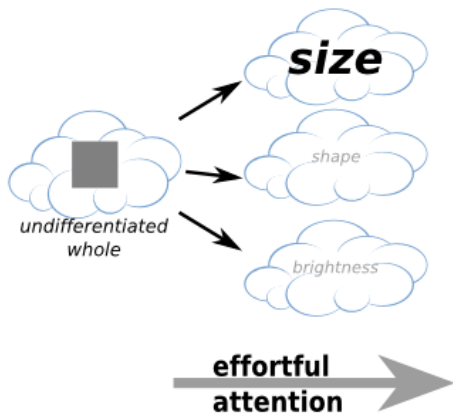
Combination Theory as *stimulus sampling*



(Estes; McLaren & Mackintosh; Lamberts)

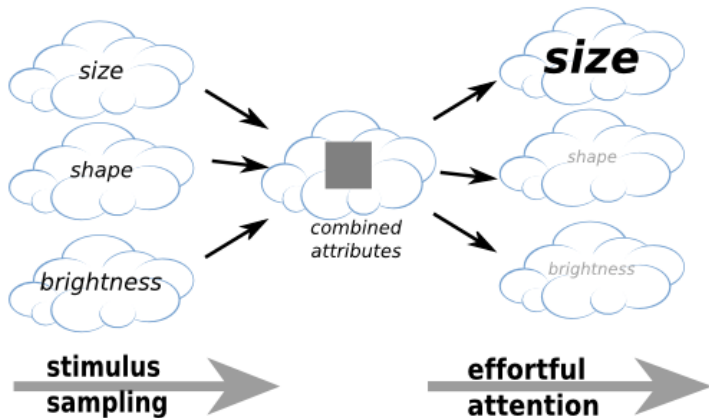
# Instantiating the theories

Differentiation Theory as *effortful, time-consuming, selective attention*



(e.g. Nosofsky & Kruschke)

# Stimulus sampling, then effortful selective attention



European Commission  
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EPS / Psychonomic Society 6<sup>th</sup> July 2007

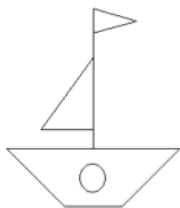
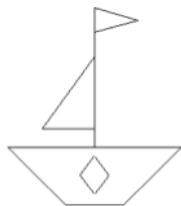
## Unsupervised categorization: Analytic and non-analytic processes

Andy Wills, Chris Longmore and Fraser Milton



The slide features four logos at the bottom: the University of Exeter logo, a stylized blue '6' logo, the E·S·R·C Economic & Social Research Council logo, and the bbsrc logo.

# Match-to-standards procedure



# Disconfirmation of Differentiation Theory

**Stimulus presentation time:** Milton et al. (2008).

**Concurrent load:** Milton et al. (2008); Wills et al. (2013a).

**Impulsivity:** Wills et al. (2013b).

**Working memory capacity:** Wills et al. (2013a).

**Instructions:** Wills et al. (2013a).

**Frontal lobe activity:** Milton et al. (2009).

**Reaction time:** Milton & Wills (2009).

**Eye gaze:** Milton & Wills (2009).

## Smith reports on animals' reflective minds



[http://www.buffalo.edu/ubreporter/archive/2011\\_03\\_03/animal\\_cognition](http://www.buffalo.edu/ubreporter/archive/2011_03_03/animal_cognition)

# Triad task



# Triad task: Assumed strategies

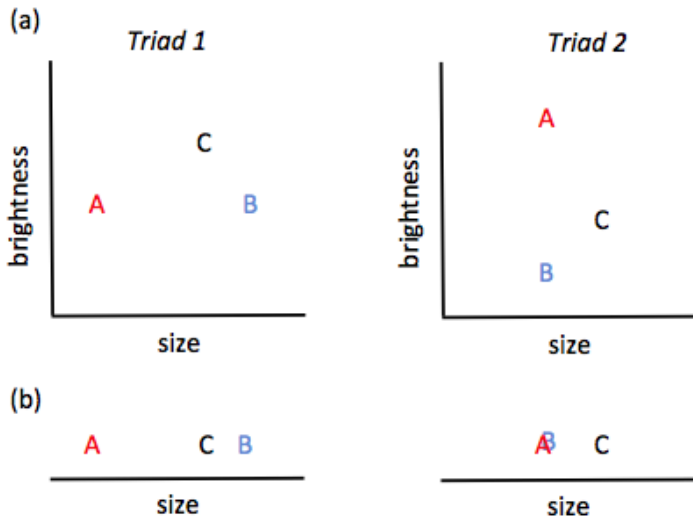
Overall similarity (Differentiation Theory: Fast)



Dimensional identity (Differentiation Theory: Slow)



# Triad task: Abstract structure



# Triad task: Single-dimension responding

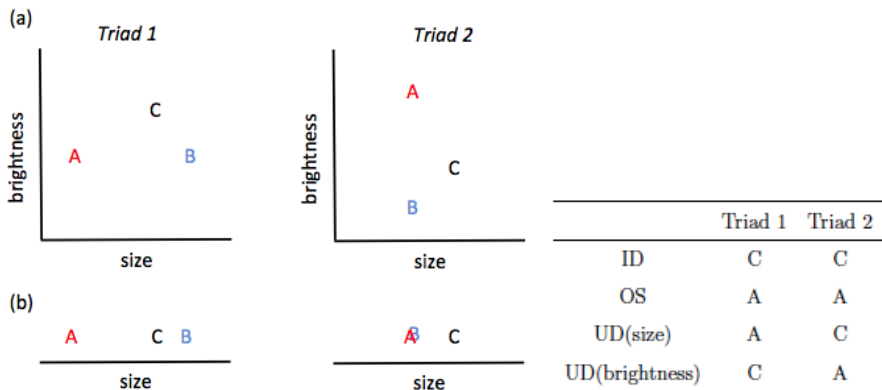
Overall similarity? Or brightness?



Dimensional identity? Or size?



# Triad task: Abstract structure



## Smith & Kemler Nelson (1984): Replication

	Traditional			Response-set		
Condition	BC	AB	AC	UD	OS	ID
1000 ms	.34	.55	.11	.38	.13	.49
5000 ms	.12	.85	.03	.10	.00	.90

## Triad task: Further experiments

**Milton et al. (2008)**: re-analysis. Differentiation Theory disconfirmed.

**Smith & Kemler Nelson (1984)**: replication. Differentiation Theory disconfirmed.

**Ward (1983)**: two slightly different replications. Both consistent with both theories.

# Deborah Kemler Nelson



<http://www.swarthmore.edu/profile/deborah-nelson>

# Criterion attribute procedure

## *Training items*

Group 1: MUFA MUFY MUSA MOFA

Group 2: VOSY VOSA VOFY VASY

## **Classification by criterion attribute**

Group 1: MUFA MUFY MUSA MOFA

Group 2: VOSY VOSA VOFY VASY

## **Classification by overall similarity** (e.g. of MUSA)

Group 1: MUFA (3), MUFY (2), MUSA (4), MOFA (2)

Group 2: VOSY (1), VOSA (2), VOFY (0), VASY (1)

## *“Critical” test items*

VUFA MOSY

# Criterial attribute procedure

## Classification by non-criterial attribute

### *Training items*

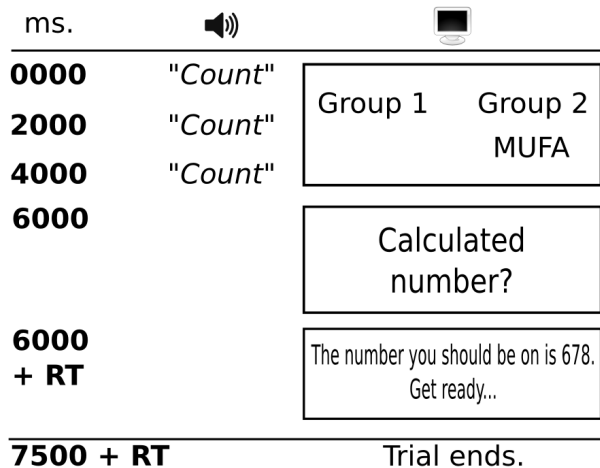
Group 1: MUFA MUFY MUSA MOFA

Group 2: VOSY VOSA VOFY VUSY

### *“Critical” test items*

VUFA MOSY

# Smith & Shapiro (1989): Replication



# Smith & Shapiro (1989): Replication

Condition	Traditional		Response-set		
	OS	CA	OS	CA	NCA
Concurrent load	.53	.47	.00	.48	.52
Full attention	.27	.73	.00	.74	.26

## Criterial-attribute procedure: Further experiments

**Smith & Shapiro (1989):** Concurrent load. Replication. Consistent with both theories.

**Kemler Nelson (1984):** Intentional versus incidental training. Two slightly different replications. Both consistent with both theories.

# Conclusion

**Combination Theory** provides a sufficient account of numerous results within the match-to-standards, triad, and criterial-attribute, procedures.

Contrary to widely-held beliefs, there seems to be no need to invoke the idea that classification begins with the analysis of an undifferentiated stimulus “whole” (**Differentiation Theory**).