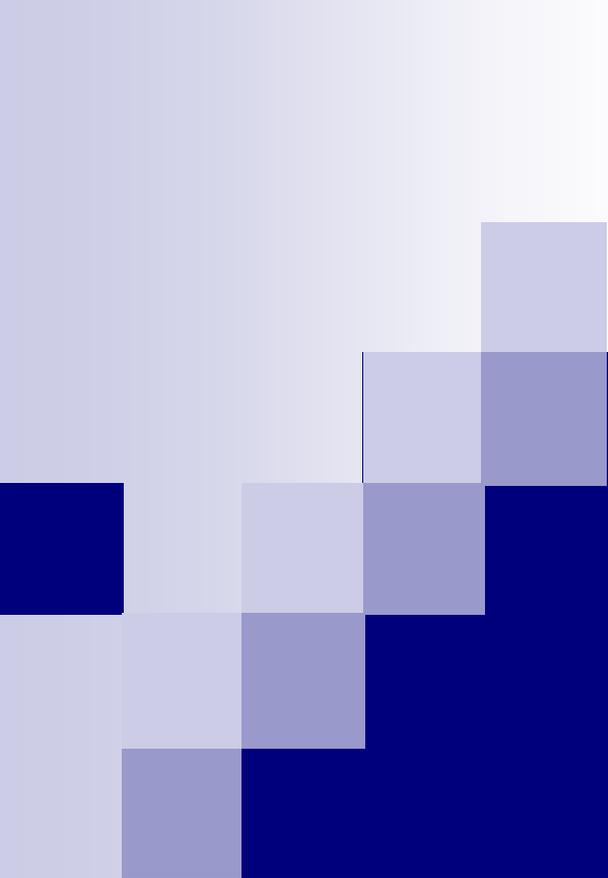


Research areas

- Connectionist models of categorical decisions
 - Wills, Suret, Stewart, Reimers and McLaren (2000)
- Free classification
 - Milton and Wills (2004)
- Exposure learning
 - Wills, Suret and McLaren (2004)
- Human associative learning
 - Le Pelley, Oakeshott, Wills and McLaren (2005)
- Category-level representations (cf. AMBRY)
 - Wills, Noury, Moberly, and Newport (2006)
- Comparative studies of categorization
 - Goto, Wills and Lea (2004)



Unitization during categorization

Andy Wills

“Senior lecturer”

Fixed or variable?

- Fixed-component models of categorization
 - Features: Medin and Schaffer (1978)
 - Dimensions: GCM, ALCOVE
- *Feature creation* approach
 - The features one perceives in stimuli can qualitatively change as a result of experience with those stimuli
 - Schyns, Goldstone, and Thibaut (1998)

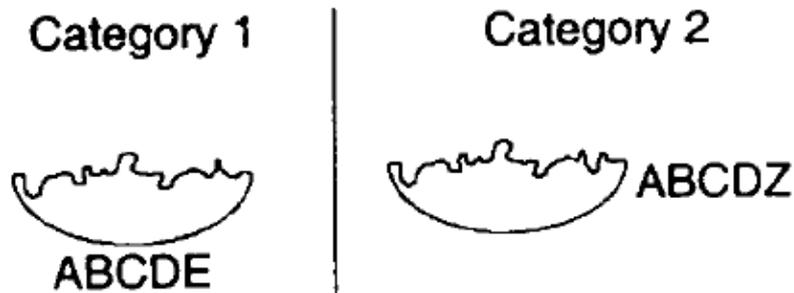
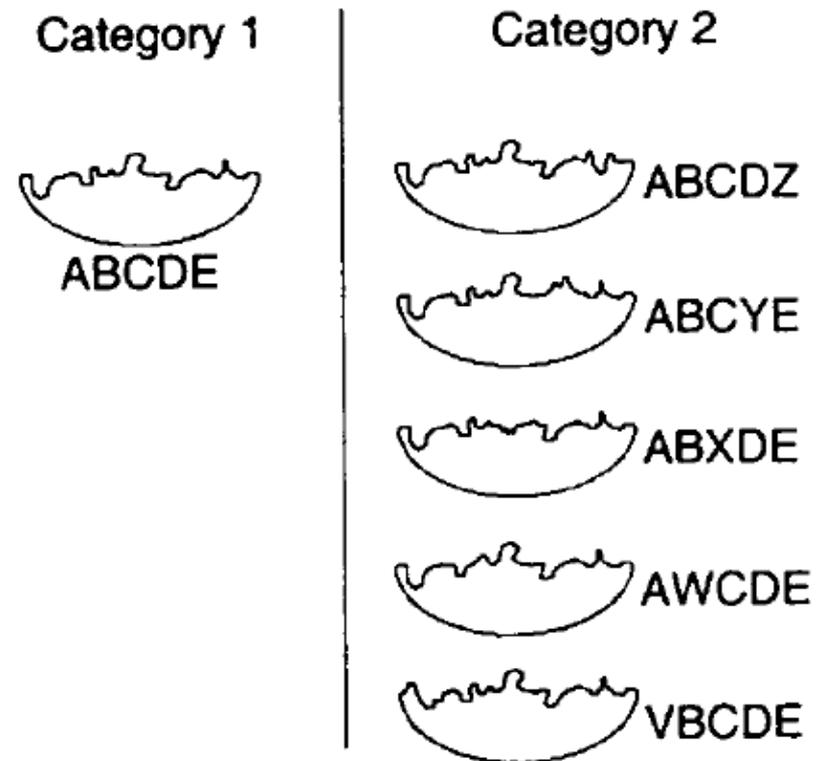


Unitization

- The fusion of a set of pre-existing features
- Hypothesized to underlie
 - Word-superiority effect (Cattell, 1886)
 - Object-superiority effect (Weisstein & Harris, 1974)
 - Effects of extended practice on conjunctive visual search (Shiffrin & Lightfoot, 1997)

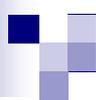
Unitization during categorization

- Goldstone (2000)
 - Extended practice on an all-component categorization results in faster responding than predicted by an independent components model from one-component RTs.



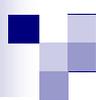
↑ All-component categorization

← One-component categorization



Current work

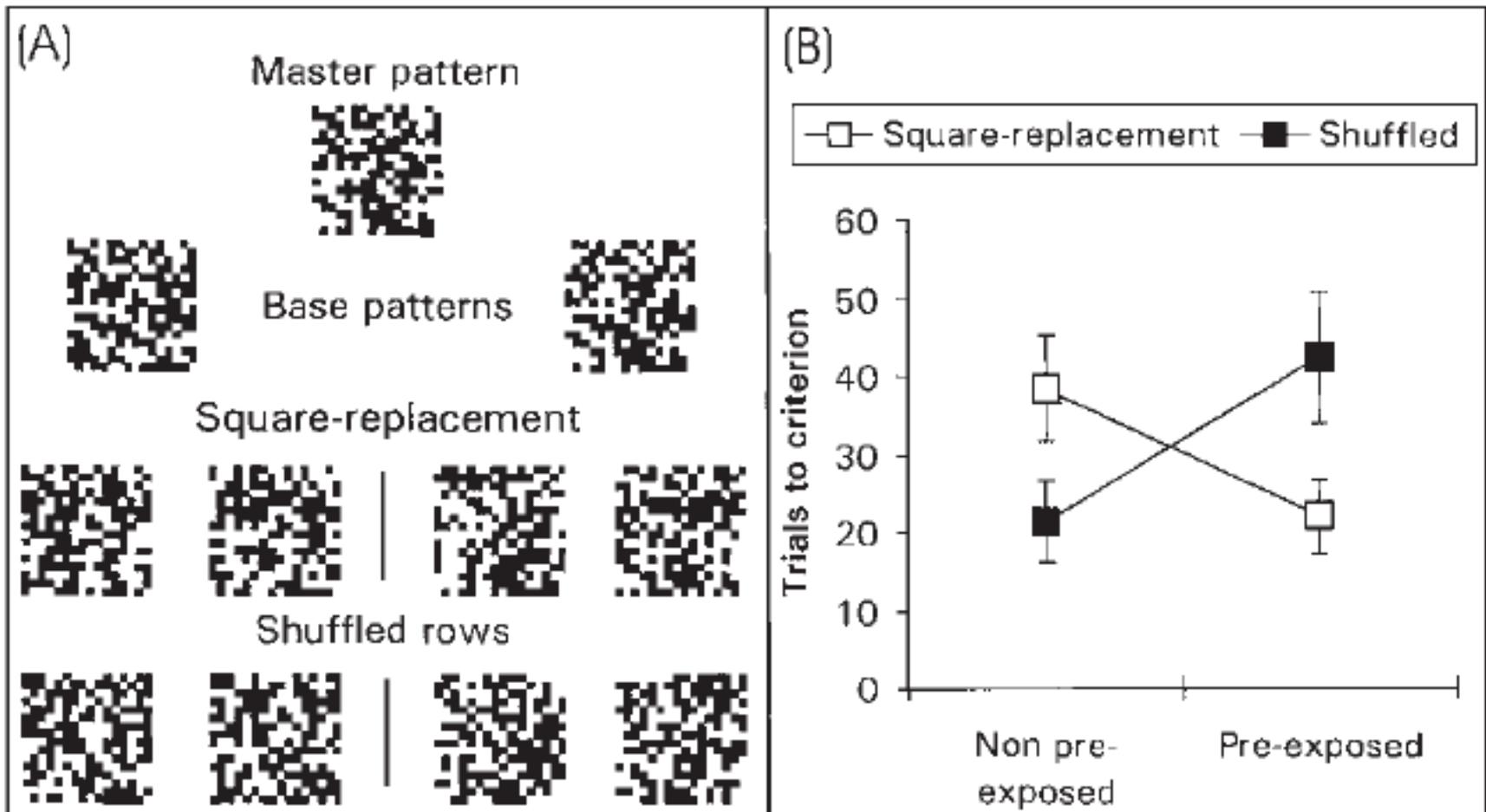
- Provide converging evidence for unitization during categorization through two further methodologies.
- Choice of methodologies informed in part by the predictions of a theory of unitization.



McLaren and Mackintosh (2000)

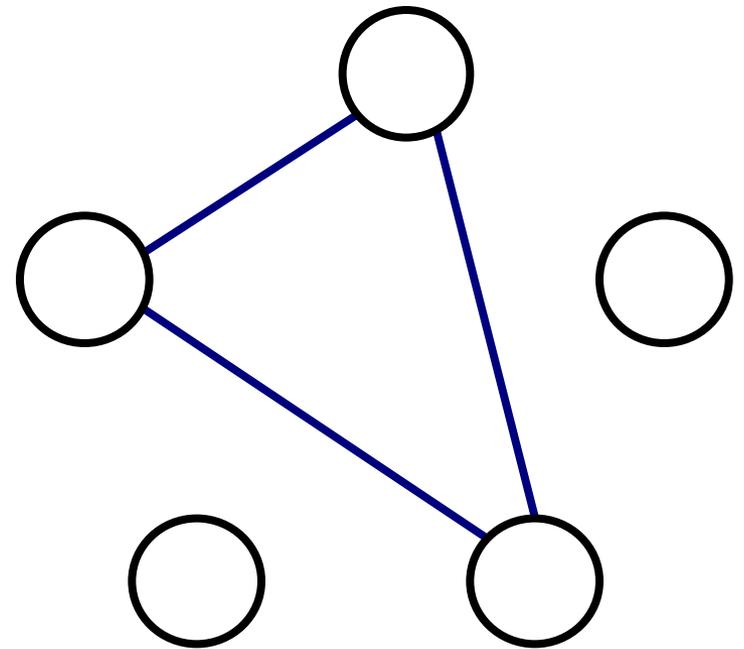
- An associative theory of perceptual learning.
- Support for this model comes from a number of its correct but non-intuitive predictions. For example...

Wills, Suret and McLaren (2004)



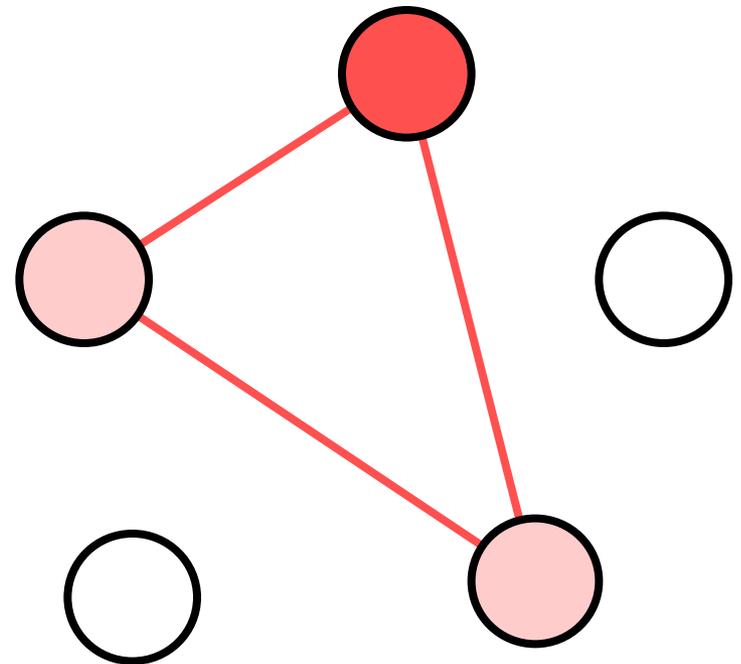
McLaren, Mackintosh account of unitization

- Formation of within-compound associations
- Data
 - Fiser & Aislin (2001)
 - Larkin, Aitken & Dickinson (1998)
- Theory
 - McClelland & Rumelhart (1985), amongst others.



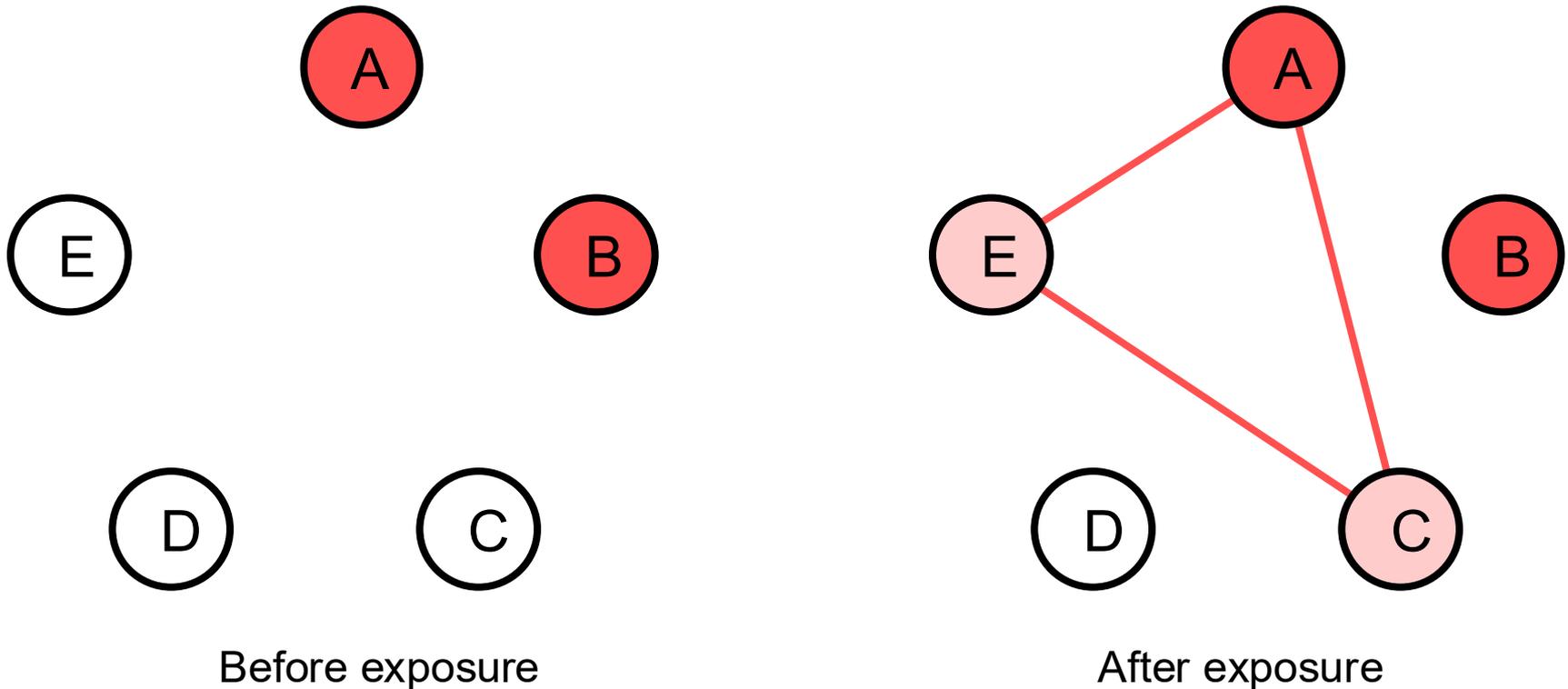
McLaren and Mackintosh (2000)

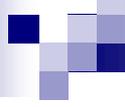
- Detection of a component facilitates detection of others.



Prediction 1: Relative salience of the unitized part of the stimulus will increase.

Following stimulus sampling theory (Estes)



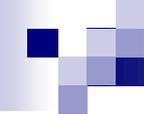


Prediction 2: Unitization will occur whether or not the unit is diagnostic of some category.

- Long-standing evidence perceptual change can occur as result of simple exposure (e.g. Gibson & Walk, 1956)
- However, recent emphasis on the role of functionality:

“these experiments investigate whether new perceptual units can be developed *if they are useful* for a category learning task” (Goldstone, 2000, p.86)

“unitization may not occur unless the task requires unitization for success” (Shiffrin & Lightfoot, 1997, p.74)



Summary

- Prediction 1: Relative salience of the unitized part of the stimulus will increase.
 - Exp. 1-4
- Prediction 2: Unitization will occur whether or not the unit is diagnostic of some category.
 - Exp. 2, 3

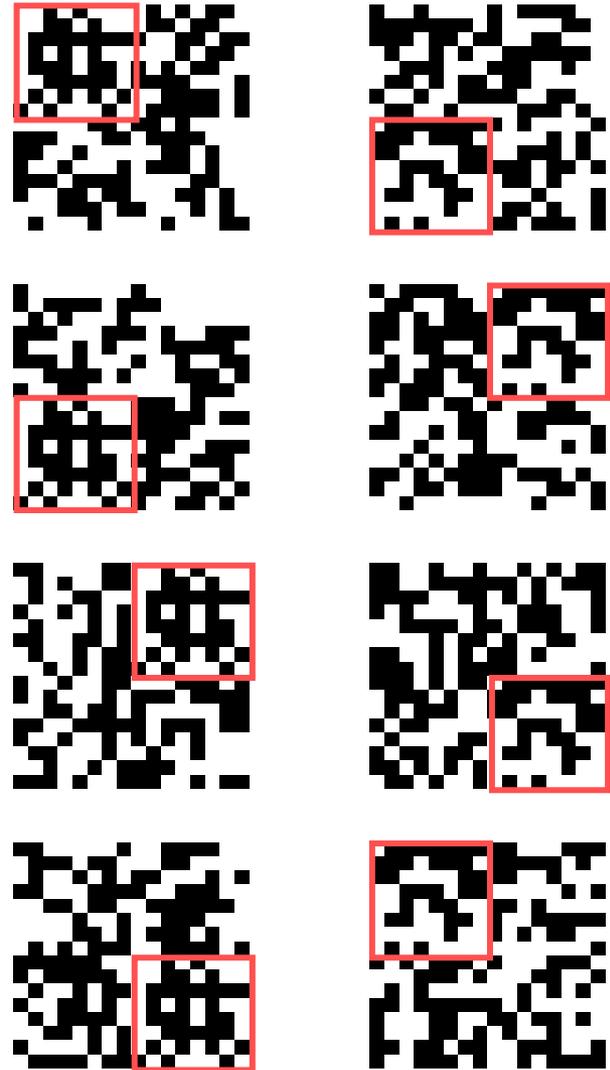
Experiment 1

- Categorization, followed by similarity judgments to assess salience change.
- Can you spot the feature?



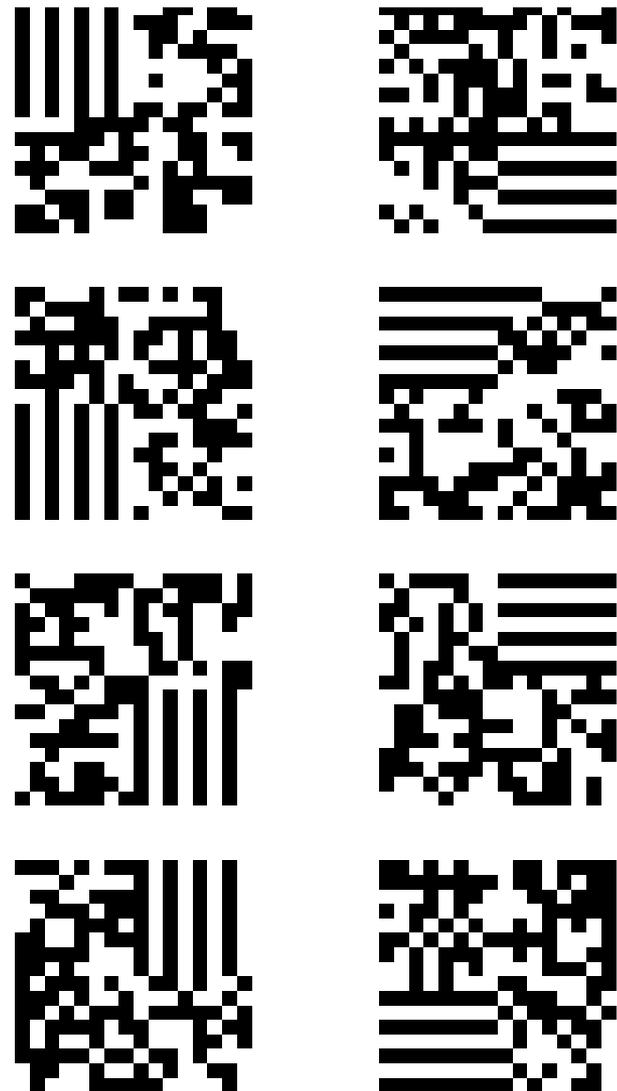
Experiment 1

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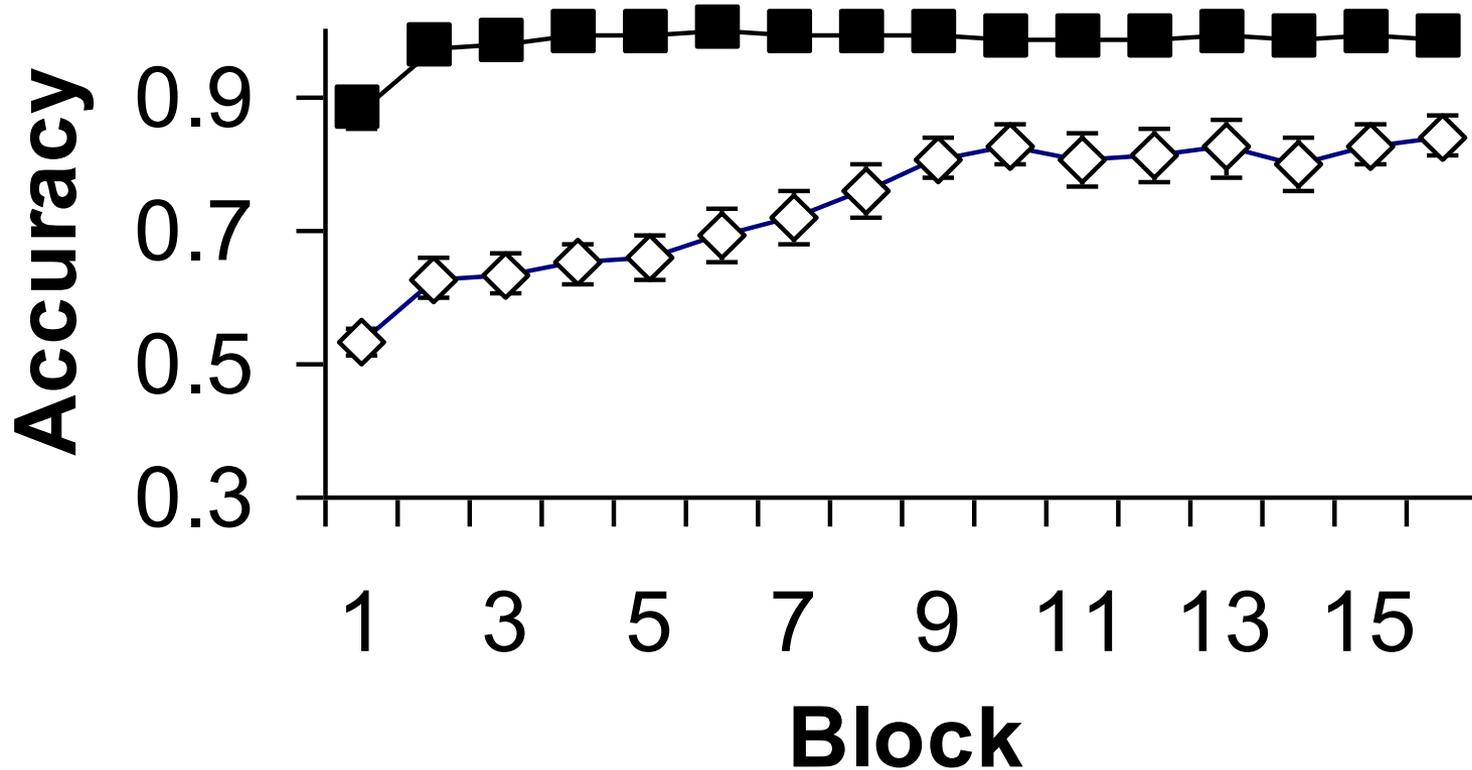


Non-unitization-related salience changes

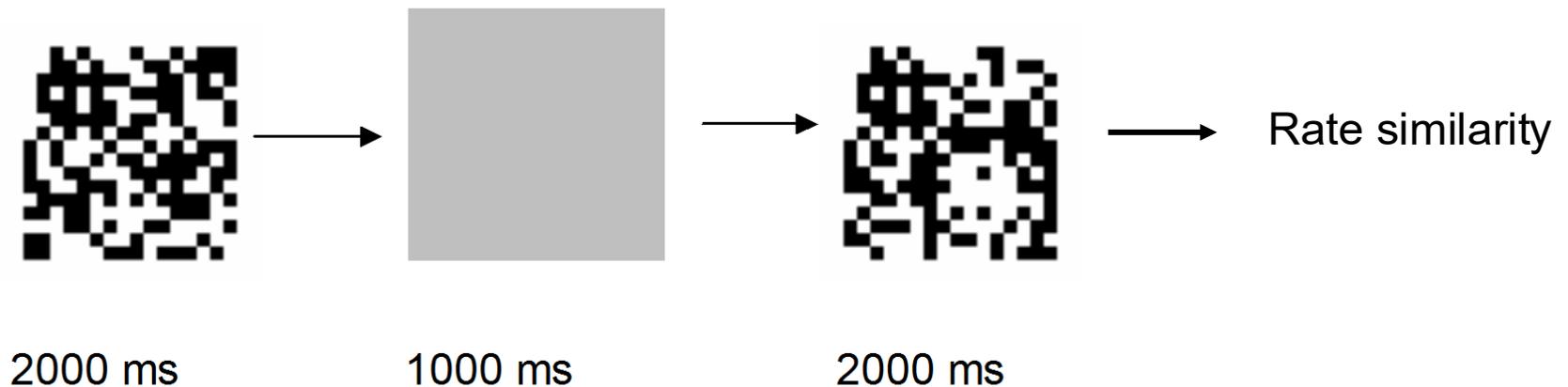
- Salience could change for other reasons.
- In particular, the attention attracted by even very familiar stimuli (e.g. words) can be modulated by the extent to which they predict an outcome (e.g. Kruschke, Kappenmann, Hetrick, 2005).



Training

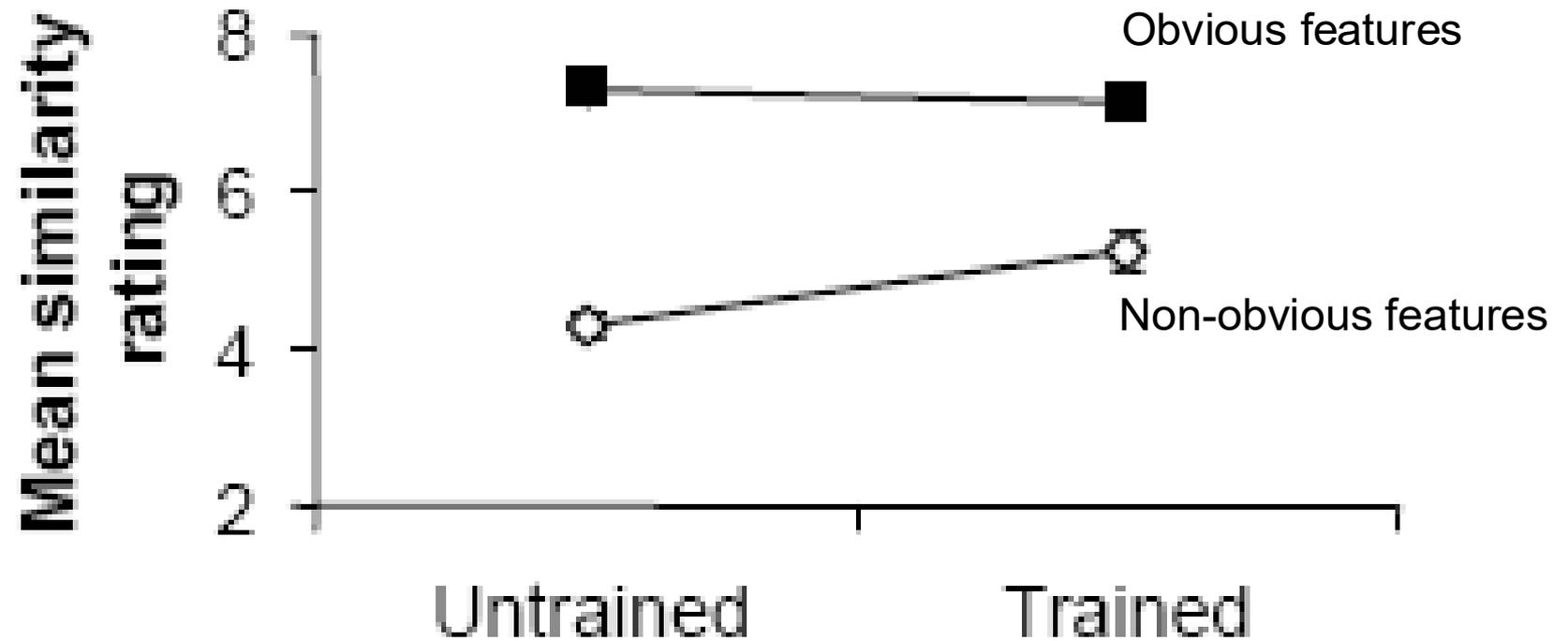


Similarity rating: Task 1



- The two patterns share the feature, but have different noise.
- Unitization should result in an increase in similarity (because the unitized component is more salient)

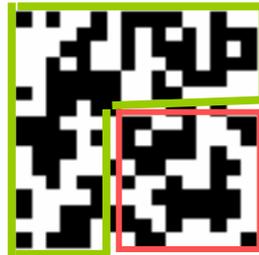
Results



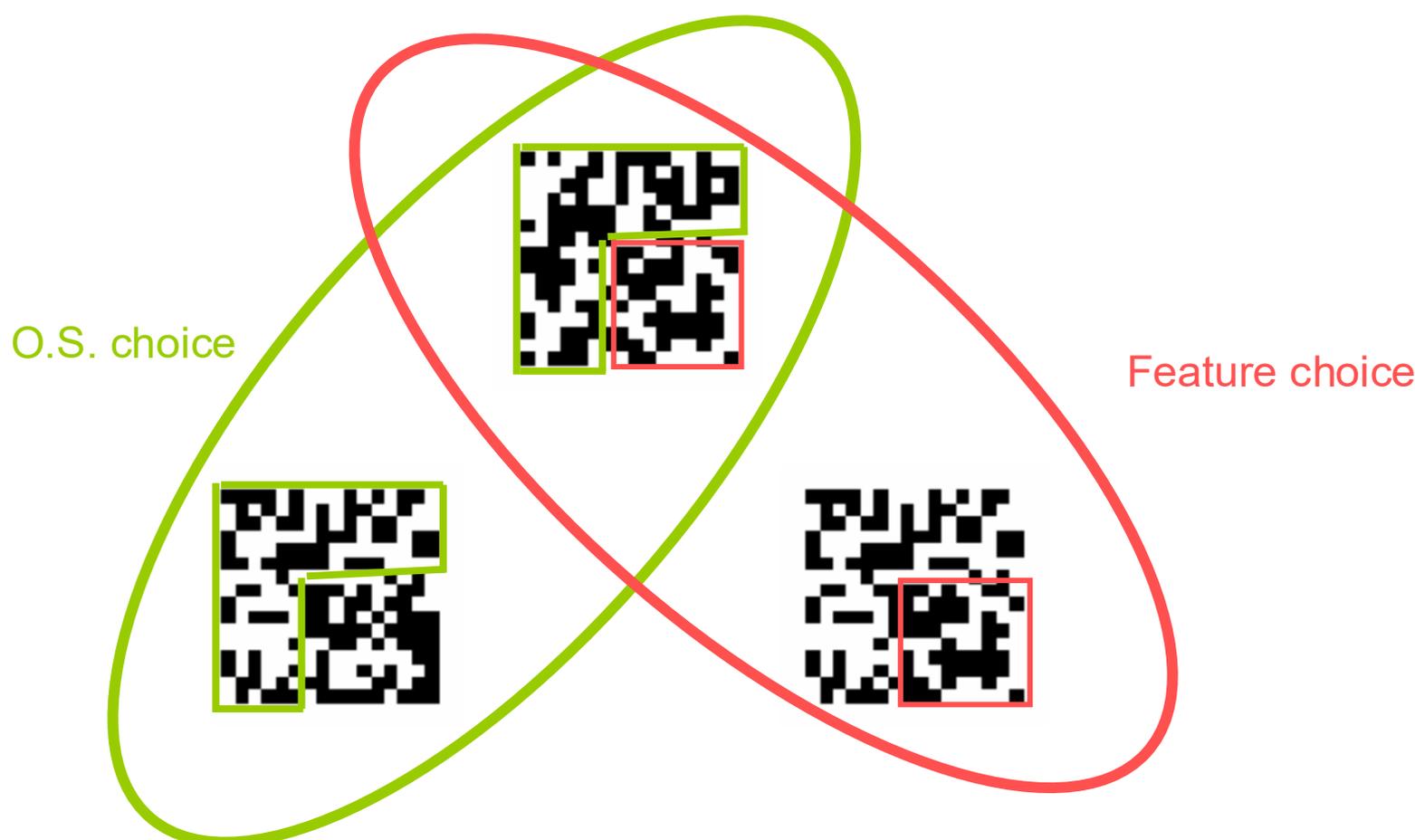
Similarity rating: Task 2



- Pick the two stimuli which are most similar (standard triad task)



- Pick the two stimuli which are most similar (standard triad task)

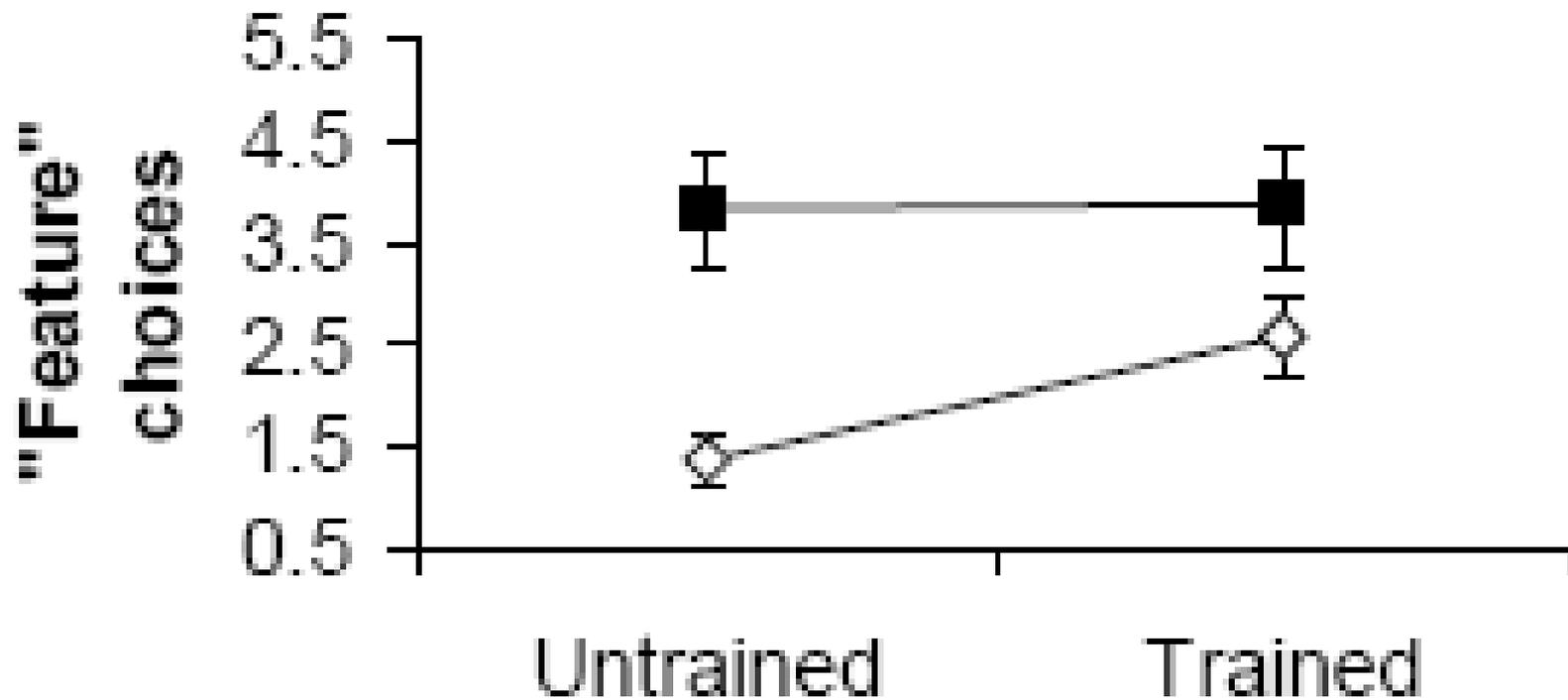


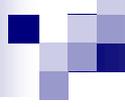
O.S. choice

Feature choice

- Pick the two stimuli which are most similar (standard triad task)

Results





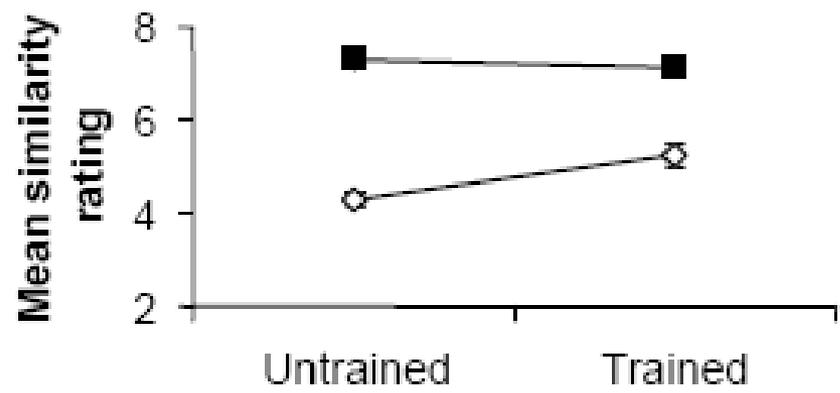
Experiment 1: Summary

- Categorization training seems to lead to an increase in the salience of category-diagnostic configurations
- This increase only occurs when the configurations are non-obvious.
- This pattern of salience change is predicted by McLaren-Mackintosh theory of unitization
- However, this theory also predicts that the same pattern of results should be observable when the stimuli are simply exposed...

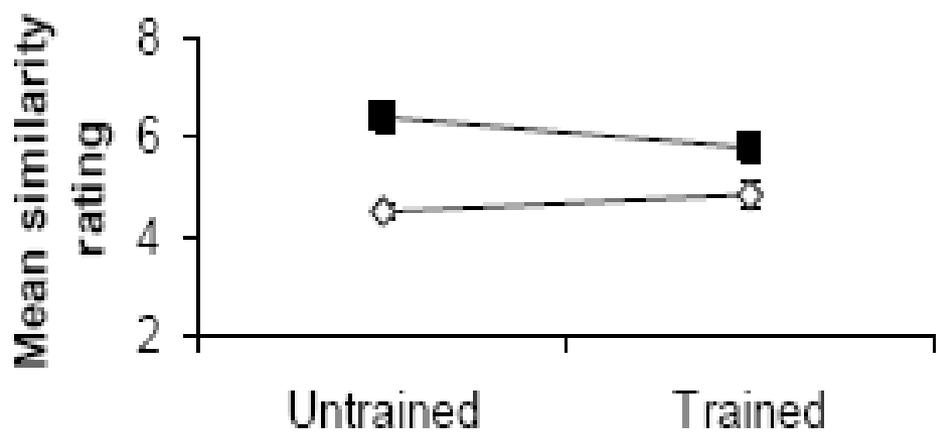


Experiment 2: Exposure

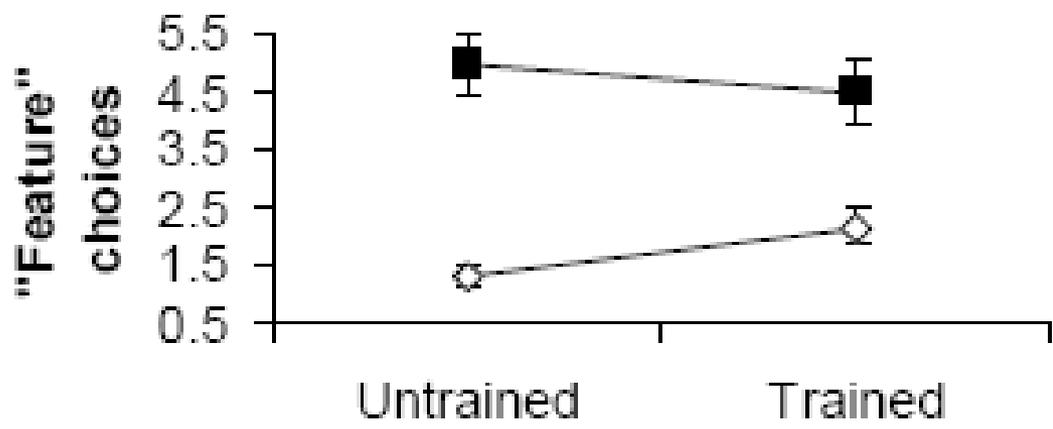
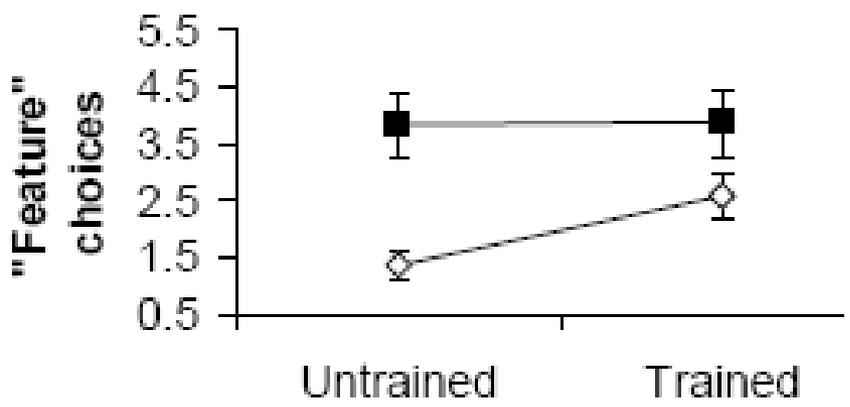
- As Experiment 1, except categorization responses are replaced by attractiveness ratings.



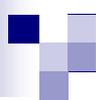
Exp. 1: Categorization



Exp. 2: Exposure



Features



Exp. 3: Unhelpful features

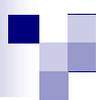
- Exp. 1 – Features predict category membership.
- Exp. 2 – Features have no explicit consequence.
- Exp. 3 – Features are actively unhelpful for the task at hand.

Experiment 3

- Exposure through running recognition.
 - Within a block, each whole stimulus (noise+feature) occurs exactly twice.
 - Task is to say, for each stimulus, whether it is the 1st or 2nd time it has occurred.
 - As before, each stimulus contains one of two features, plus stimulus-unique noise.
 - So, the feature is actively unhelpful because it is the only part of the stimulus that cannot be used to determine whether the stimulus has been presented before.
- Attention would be expected to be diverted away from the feature in order to assist completion of task.
- Unitization-related salience increase might be expected to partially offset this for the non-obvious features (despite this being unhelpful for the task at hand)

Results



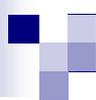


Converging evidence

- Experiments 1-3 based on similarity ratings.
 - Some have argued that similarity ratings are “particularly prone to task demands and explicit strategies” (Goldstone, Lippa & Shiffrin, 2001, p. 30).
 - A task demands explanation of Exp 2 & 3 is not immediately apparent but, nevertheless, converging evidence from a different measure of salience might support the case made by Experiments 1-3.

Eye-tracking

- Eye-tracking dwell time is increasingly being used as a measure of overt attention in studies of categorization
 - Rehder & Hoffman (2005)
 - Kruschke et al. (2005)
- Examining an overt attention measure should give additional information. It is not immediately obvious what effect unitization should have on overt attention:
 - Overt attention could be directed towards salient parts of the stimulus.
Increased unitization = increased overt attention
 - Alternatively, one of the benefits of unitization might be to reduce the need for foveation.
Increased unitization = decreased overt attention.
- Exp. 1 might be taken to suggest that our similarity ratings do not measure changes in overt attention (because NOF show trend for reduced salience)

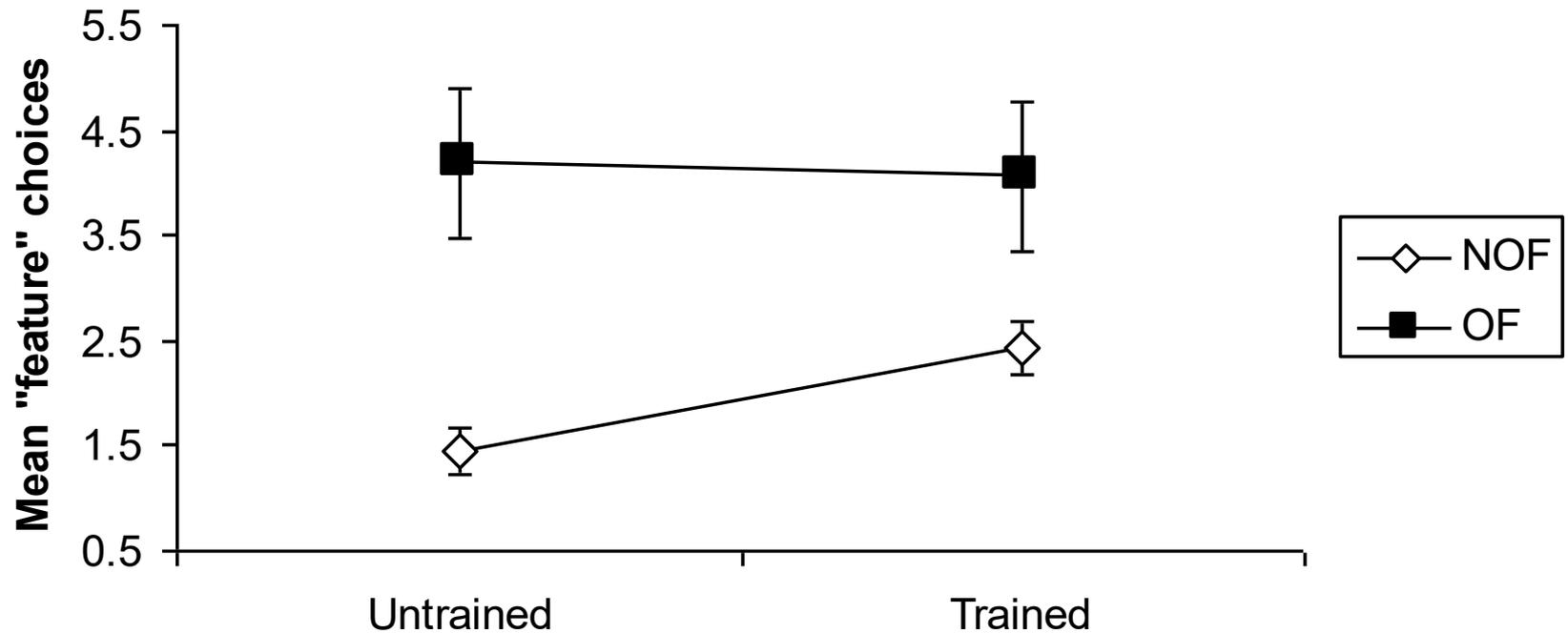


Role of functionality

- Cross-experiment comparison of Experiments 1 to 3 fail to reveal any significant differences of different types of exposure.
- Re-examined in this experiment – which has both categorization and simple exposure conditions.
- This experiment only used the triad similarity task.

Results

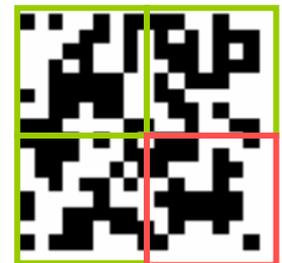
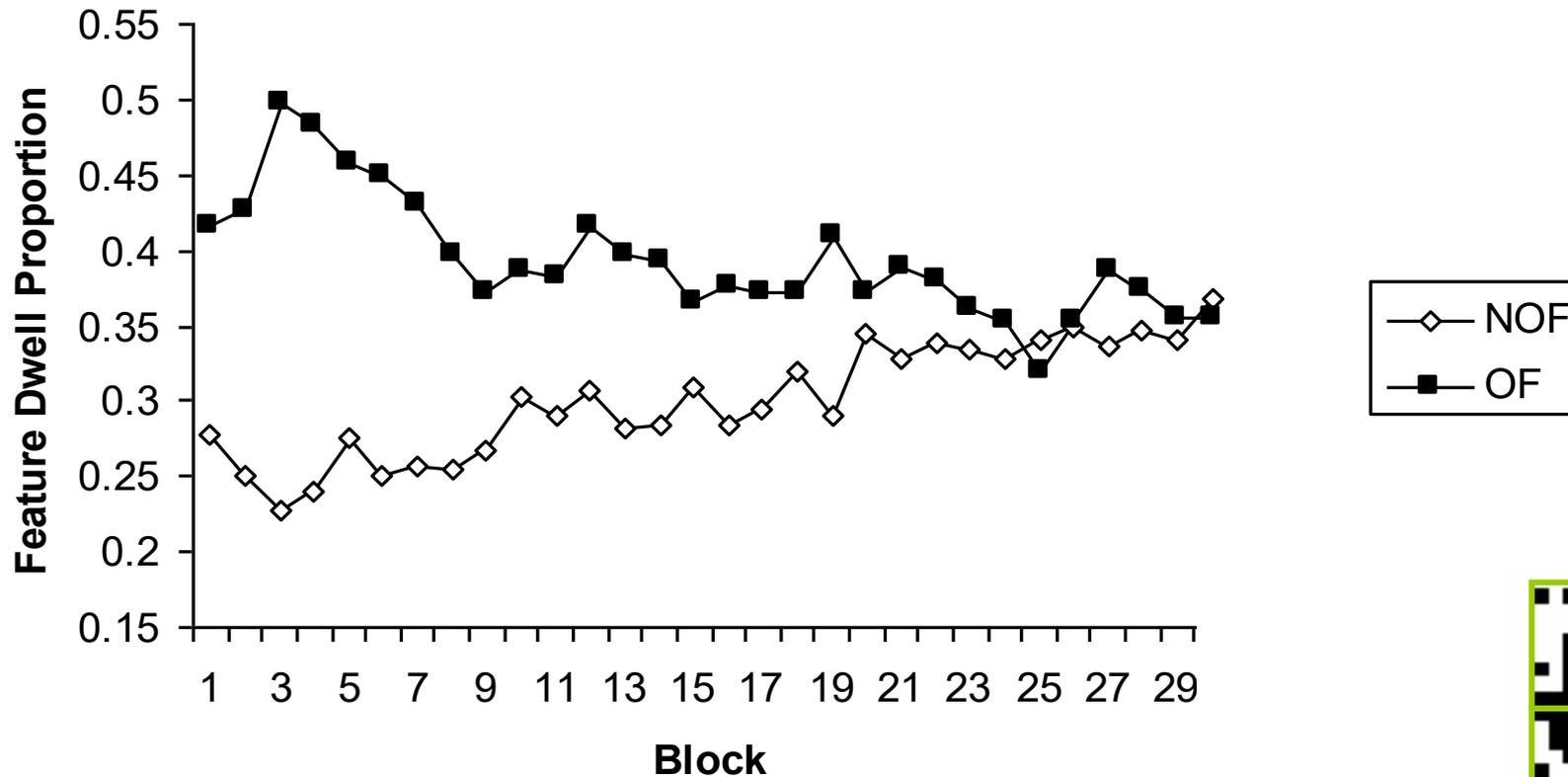
Triads



Again, no effect of exposure type (graph above shows average)

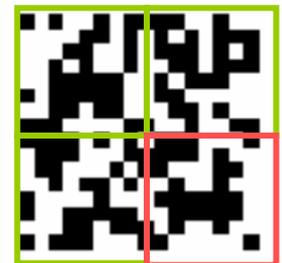
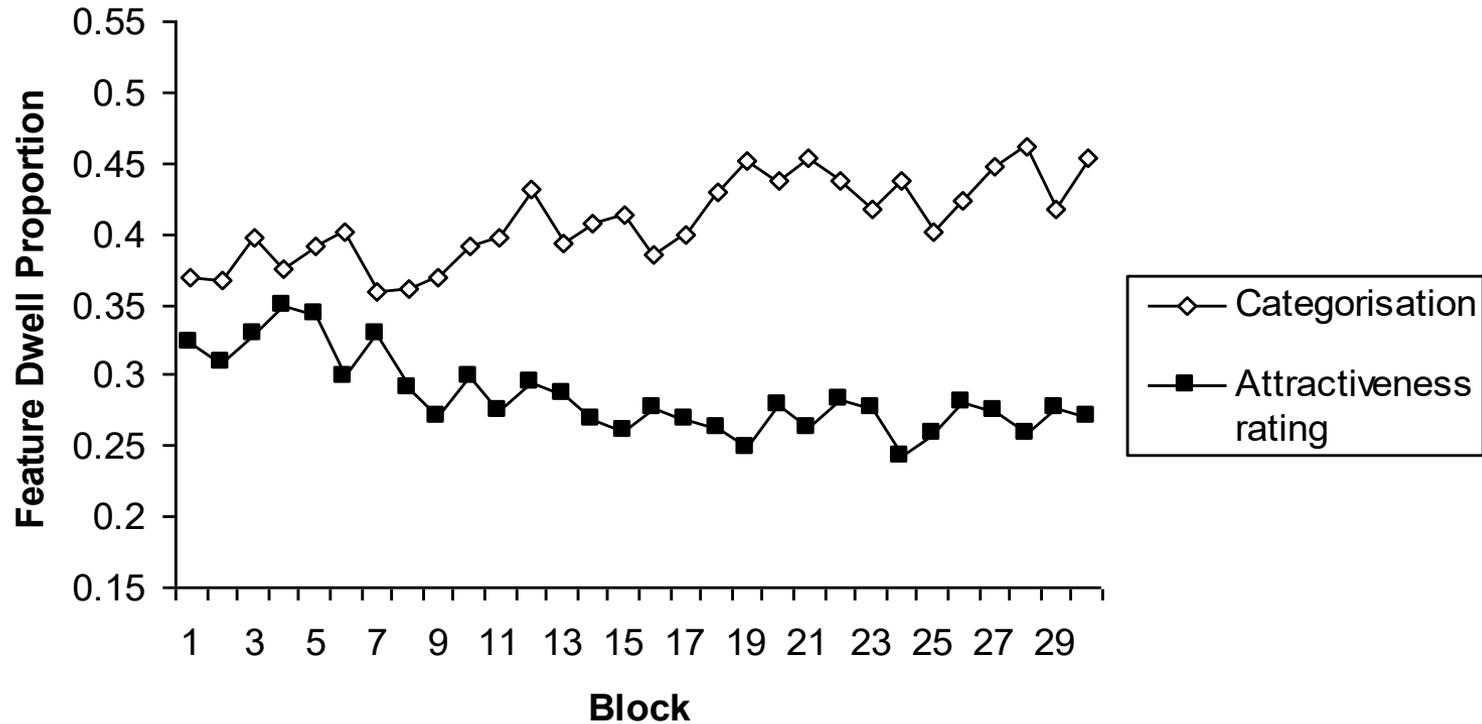
Eye-tracking

Feature Dwell Proportion: Block x Feature type interaction



Eye-tracking

Feature Dwell Proportion: Block x Training Type interaction



Summary

- Exposure and salience
 - Repeated exposure to already-familiar features tends to reduce their salience.
 - Repeated exposure to non-obvious unfamiliar features increases their salience.
 - These effects are predicted by McLaren-Mackintosh unitization, i.e. by
 - Within-compound associations, plus
 - Estes stimulus sampling theory.

- Diagnosticity and salience
 - Features that predict category membership increase in salience.
 - Features that predict no particular outcome decrease in salience.
 - These effects are predicted by standard attentional associative theories, e.g.
 - Mackintosh (1975) or Kruschke (2001)
 - Pearce-Hall (1980)

- Theories of categorization should be able to account for both types of representational change. For some attempts in this direction, see

Wills, A.J. (2005). New directions in human associative learning. LEA.