Face Distinctiveness is a Better Predictor of Remember/Know Judgments than is Study List Organization

Gerald A. Epling
MindJava

Abstract

Varying the level of organization between two different study lists provides one method of selectively engaging two complementary psychological processes; item-specific processing and relational processing. These primitive processes of cognition may also be selectively engaged by different levels of distinctiveness in the stimuli. Review of data from a recent face recognition study shows that the substitution of face distinctiveness for study list organization produces an improved model of face recognition, accounting for more than 75% of the variance in the production of correct remember and know judgments with one encoding trial and with multiple encoding trials.

Method

Sixty-four subjects were randomly assigned to one of four groups upon arrival at the lab. One group performed an item-specific encoding task with 36 faces and another group performed a relational encoding task with 36 faces. A third group performed the item-specific encoding task three times, and the fourth group performed the relational encoding task three times. A recognition test was given at the conclusion of the encoding phase. Stimuli for the recognition test included the 36 studied faces and 36 unstudied faces. The data set for this study consisted of 4,608 data points produced by 64 human subjects drawn from the undergraduate population at the University of Texas at Dallas.

Theoretical Framework

The experiment was planned based upon a multiple process framework of memory formation that derives from three expectations.

1. Item-specific processing produces distinctiveness in the mind.
2. Relational processing supports the organization of items in memory.
3. Essential Processing supports the storage of memory. Memory storage takes time, it is not instantaneous.

Since this framework has not yet been published in the psychological literature the expectations regarding the interactive nature of item-specific processing and relational processing will be presented here.

1. Within-item relational processing is strictly inclusive.

- Within-item relational processing is a contributor to item-specific processing when the stimuli are sufficiently complex, as faces are.
- Within-item relational processing supports the binding of the elements of the face, such as the eyes, nose, mouth, and chin into a single distinct face.

2. Between-item relational processing supports the exclusion of an individual item from categories, groups, or subgroups as well as the inclusion of an item within a category, group, or subgroup.

3. Item-specific processing and relational processing are complementary processes.

- If an item is perceived as being distinctive then relational processing is engaged.
- If the similarity of an item to other items is sufficient to impede the assignment of the item to a category, then item-specific processing is engaged until the item is sufficiently distinctive as to be separable from the other similar items.

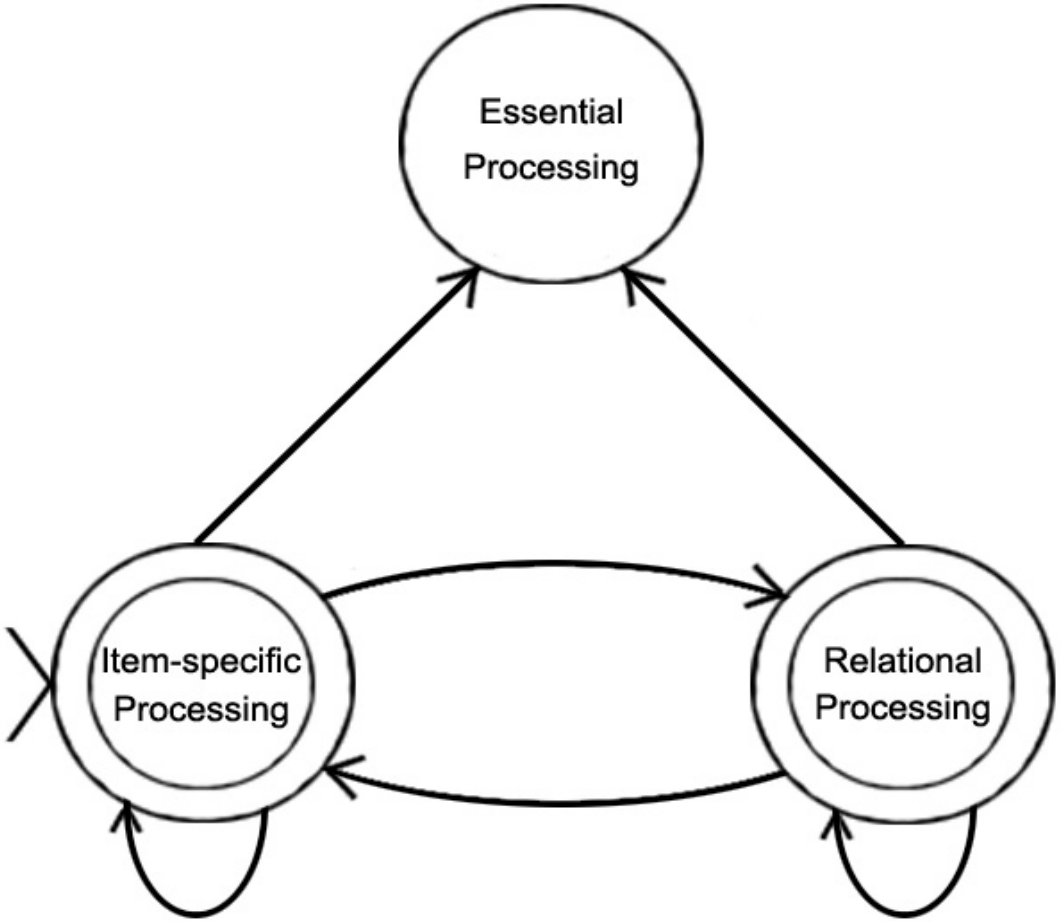
4. Memory formation takes time and recognition memory improves over time as memory is formed by essential processing.

5. Know judgments are attributable to item-specific processing.

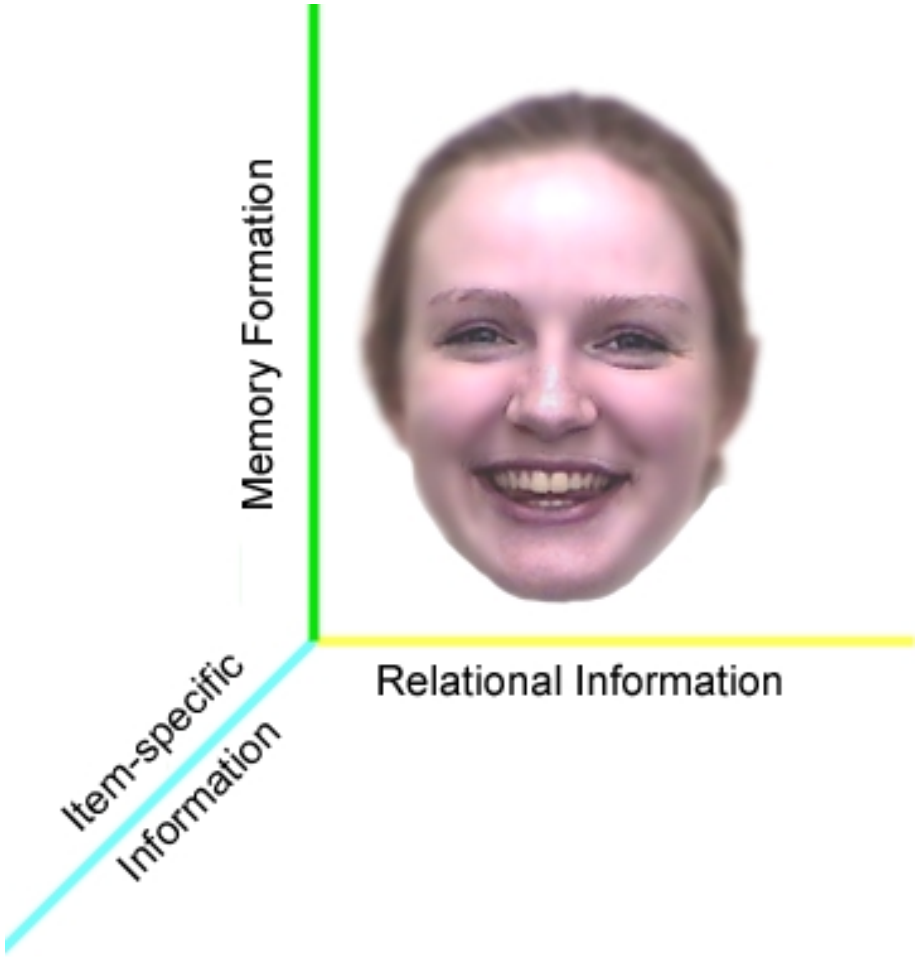
6. Remember judgments are attributable to relational processing.

These six expectations take into account the fact that encoding tasks are typically not process pure. Each encoding task engages item-specific processing, relational processing and essential processing. So, the expectation is that each task will result in a mixture of remember and know judgments.

Both item-specific processing and relational processing inform essential processing, which is the memory storage process. This memory storage process is called “Essential Processing” because it is essential to the acquisition of knowledge. All of the different neural substrates of memory formation, such as those associated with visual memory or verbal memory are represented in essential processing. The dynamic interaction of these three processes of memory formation is shown in the figure titled, “Three part model of memory formation”.



Three part model of memory formation. Memory formation begins with one or more iterations of Item-specific Processing followed by zero or more iterations or Relational Processing. The activity may be repeated. Information for Essential Processing may be supplied by Item-specific Processing or Relational Processing.



As the eyes scan the nose, the mouth, the chin, the eyes, and eyebrows these elements are provided to essential processing and the memory storage process is engaged.

Distinctive Faces. Distinctiveness rating of 4.4 on a scale of 1 to 6.

Typical Faces. Distinctiveness ratings of 2.2 and 2.3 respectively on a scale of 1 to 6.

	Overall Recognition		Remember Judgments		Know Judgments	
Source	H-FA	Correct	H-FA	Correct	H-FA	
All Conditions	.59	.85	.79	.81	.76	
1 Encoding Trials	n.s.	.84	.78	.79	.64	
3 Encoding Trials	n.s.	.85	.78	.82	.79	

Accounting for 79% or more of the variance in correct remember and know judgments, with multiple encoding trials. R^2 Values for the model of face recognition based upon encoding task and distinctiveness of stimuli as measured by Overall Recognition (H-FA), Correct Remember Judgments, Remember H-FA Scores, Correct Know Judgments, and Know H-FA Scores.

*MODEL Remember Know =
task
multiple
task*multiple
subject(task multiple)
stim
task*stim
multiple*stim
task*multiple*stim
stim*subject(task multiple);

where: task = encoding task
multiple = number of encoding trials
stim = distinctiveness of stimuli

*Copies of the analyses are available for perusal at the 2002 Annual Meeting of the Psychonomic Society.

Comparison of factors - study list versus face distinctiveness

An analysis of the data based upon a desire to replicate findings from the verbal literature considered the effects of encoding task, level of study list organization, and number of encoding trials on face recognition. This model did a good job of highlighting the differences in the production of remember and know judgments at different levels of learning with different encoding tasks but had a problem with covariation among the experimental variables. Using η^2 to derive an estimate of the variance attributable to: 1) encoding task, 2) number of encoding trials, 3) study list, 4) an interaction between the encoding task and study list, and 5) an interaction between the number of encoding trials and study list produced an estimated contribution for each of the variables of 38.6%, 11.1%, 37.2%, 20.1%, and 7.0% respectively. Taken together this amounts to 114%, indicating some covariation in the experimental variables.

In order to overcome the problems inherent with using two different levels of study list organization as a factor in the model of face recognition the study list variable was replaced with face distinctiveness. With the substitution of face distinctiveness for study list organization acceptable R^2 values were obtained.

Discussion

In the current three-process based explanation of memory formation, the effect of essential processing, which is measured in the amount of time for a specific memory system to encode information, is one contributing factor. The other two contributing factors are item-specific processing, which produces distinctiveness in the mind and relational processing, which organizes elements of memory.

Previous research has demonstrated the effectiveness of item specific processing in the production of know judgments and the effectiveness of relational processing in the production of remember judgments (Epling, 2000a). However, the earlier dual-process model supporting the explanation of remember and know judgments did not explicitly provide for the transition from remember to know judgments as a transition from episodic remembrance to semantic memory. This is accounted for in the three-part model of memory formation by the introduction of essential processing. The expectation that essential processing proceeds over time, even in the absence of repeated study is supported by earlier research demonstrating hypermnesia with recognition memory for visual stimuli (Epling, 2000b).

The demonstrated effect of two different processes on the production of two different types of memory brings the practice of preprocessing recognition data according to d′ methods under suspicion. With the dissociation of remember and know judgments that Gardiner and colleagues (c.f. Gardiner & Richardson-Klavehn, 2000) accomplished with studies of recognition memory between 1988 and the turn of the century, one must ***either*** reject their entire line of research ***or*** accept the fact that recognition proceeds from two different types of memory. If recognition memory draws on two or more different types of memory then the normalization of raw recognition data to d′ values is not an acceptable method of preprocessing recognition data. The reason that the d′ approach is unwarranted is that d′ analysis assumes that the data being normalized according to the method are derived from a single underlying process.[1]

Conclusion

The effectiveness of a manipulation of study list organization can be measured by cluster analysis if subjects write down what they recall. This approach is well suited to studies involving verbal materials where a series of recalled words can easily be written down. However, testing memory for faces is generally accomplished with recognition testing and not with recall testing. Without the ability to test for clustering the only measure of the effect of study list organization is found in an expected interaction between study list organization and encoding task. The interaction between study list and encoding task is a good indication of the complementary nature of item-specific processing and relational processing but it does not provide a *direct* indication of how organized the study list is perceived to be. In the current face recognition study the item-specific encoding task was rating faces for distinctiveness. The distinctiveness ratings supplied in the one encoding trial condition were used to get a direct indication of how distinctive the faces were perceived to be.

In the current study of face recognition a model that included study list organization resulted in expected interactions and inflated the amount of variance accounted for by the model, leading to unacceptable levels of covariance among the experimental variables. This covariation was overcome by replacing the factor of study list organization with the factor of face distinctiveness. When this exchange was accomplished then the effective modeling of face recognition was enhanced.

The factors of face distinctiveness and encoding task provide a good basis for modeling memory formation for faces within the experimental method presented here. Interestingly, this model is equally valid for data derived from a one encoding trial experience, for data derived from a three encoding trials, and for an overall analysis including all encoding conditions.

References

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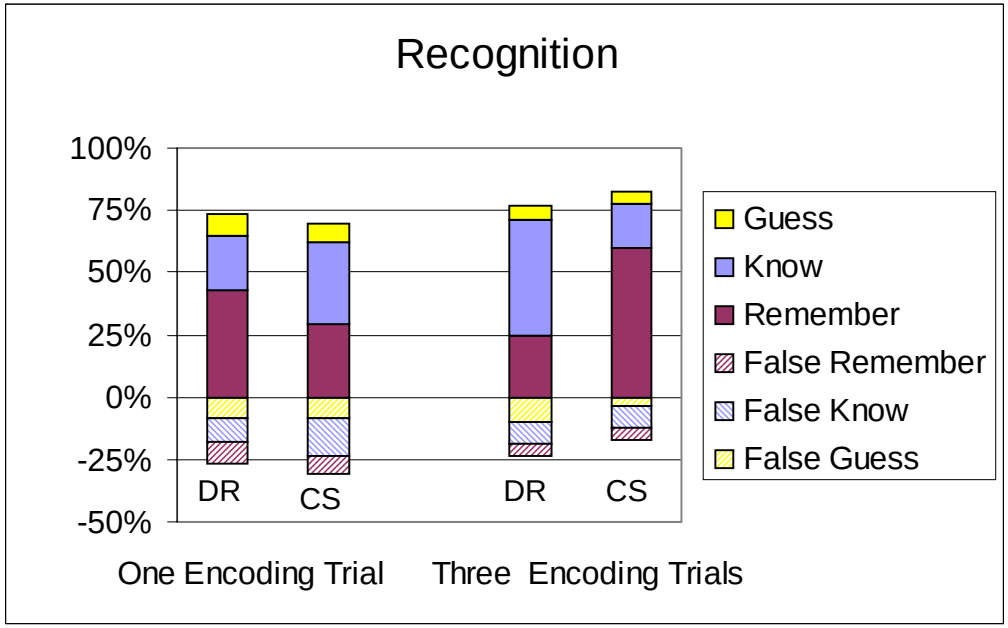
End Note

1. The strong proponent of a single process explanation of recognition memory might argue that it is possible to devise a scheme for decomposing raw recognition data and weighting the components to synthesize a form of representative data that is amenable to normalization by methods associated with d′ and that in this way d′ could then be applied to recognition memory. However, the whole process seems unnecessarily complicated regarding studies into the nature of memory formation. As far as the use of d′ as a method of adjusting for bias in recognition memory - the expectation that recognition memory is composed of both familiarity information and relational information calls into question the effectiveness of d′ in compensating for bias. Recognition accuracy could be reasonably represented by the simple method of subtracting false alarms from hits in the absence of d′ methodology.

Appendix

The empirical results supporting the newly proposed three process model of memory formation are shown in the figure below.



Decomposition of recognition by encoding task, number of encoding trials, and subjective judgments. DR represents distinctiveness rating encoding task and CS represents category sorting encoding task (Epling 2000a).