Recognizing the Unstudied Face:

The Effect of Prolonged Relational Processing

Gerald A. Epling
MindJava

Abstract

In this study, which contrasts the effects of relational processing and item-specific processing, a postulated decrease in the ability of subjects to distinguish between studied and unstudied faces (conjunctions) was observed with increased levels of relational processing. Under similar conditions, there was no decrease in the ability to reject conjunctions for the contrasting, item-specific encoding condition. Conjunctions were formed for this study by replacing the eyes and nose from one face with the eyes and nose of another face. The observed ability on the part of the item-specific processing group was attributed to the binding activity of item-specific processing.

Introduction

Recognition is based upon two different memory sources. One basis for recognition is familiarity and the other is a recollection that includes associations formed at the time of encoding. Given that there are two different forms of memory that support recognition, it is reasonable to consider the possibility that two different primitive processes of cognition support these two different forms of memory. In one recent face recognition study, a connection was shown between a predominantly relational encoding task and recognition based upon familiarity (Mäntylä, 1997). In this same study, a connection was observed between a predominantly item-specific encoding task and recognition based upon memory that included associations made during the encoding activity. These results were replicated with one encoding trial and reversed with three encoding trials (Epling, 2000; Epling & Barlett, 2000).

Epling (2000) suggested the following explanation for the observed effects due to item-specific processing. With low levels of learning (one encoding trial), a predominantly item-specific encoding task promoted within-item relational processing. This within-item relational processing supported the binding of the elements of a face (eyes, nose, mouth, hair) into an individual item. With higher levels of learning (three encoding trials), the binding process was completed and faces were recognized as individual items based to a large extent on familiarity.

This explanation is best understood in the light of the complementary nature of Item-Specific Processing (ISP) and Relational Processing (RP).

Relational processing is not possible without the definition of at least two elements to serve as the items to be related. This principle applies directly to the study of faces. Before faces can be sorted into different categories the subject must be able to distinguish one face from another. The ability to distinguish one face from another is developed by item-specific processing. This requires an initial engagement of item-specific processing in a between-item relational processing encoding task.

In contrast with the predominantly relational encoding task of category sorting, rating faces for distinctiveness is a predominantly item-specific encoding task. The primitive process that is predominantly engaged in the early stages of distinctiveness rating is within-item relational processing. This within-item relational processing supports the binding of the elements of a face; such as the eyes, nose, mouth, and hair into an individual item. When binding is promoted, subjects are able to correctly reject a special class of unstudied faces known as conjunctions. Conjunctions are formed by interchanging various elements of one studied face with another.

This explanation can be tested by contrasting the benefit gained from an item-specific encoding task to the benefit derived from a relational encoding task with respect to the ability to discriminate between studied faces and conjunctions. In this study, conjunctions were formed by taking the eyes and nose from one studied face and exchanging them with the eyes and nose of another studied face. The following prediction is based upon the expectation that the elements of a face are bound together by item-specific processing.

Expectation:

With three encoding trials, subjects in the item-specific encoding condition will have an advantage over subjects in the relational encoding condition with respect to the ability to distinguish between studied faces and conjunctions. This advantage will be due to a postulated reduction in the ability to reject conjunctions that is associated with repeated performance of a relational encoding task.

Method

Materials. Seventy-two black and white pictures of middle-aged men with similar features and haircuts were used in the experiment. Each picture was edited to show the head and a portion of the neck fading away in vignette form. Each face was printed onto a card measuring 4 ¼ by 5 ½ inches. Each face was about 3 ½ inches tall, subtending a nine-degree visual angle at the average viewing distance of 22 inches.

The set of 72 faces was randomly divided into two sets of 36 faces. Each set of 36 faces was rated for distinctiveness on a scale ranging from one (Very Typical) to six (Very Distinctive) by 16 people. Distinctiveness ratings for the two sets were 3.4 and 3.5 with standard deviations of 2.1 and 2.9 respectively. Each set served alternatively as a study list or as a set of lures for recognition testing.

Conjunctions were formed by taking the eyes and nose from one face and exchanging them with the eyes and nose of another face. Ten conjunctions were formed from studied faces and replaced those ten studied faces at test. Test materials consisted of 26 studied faces, 10 conjunctions, and 36 faces that were not previously presented.

Participants. Thirty-two undergraduate students at the University of Texas at Dallas participated in the study.

Design. The experiment's design contrasted two encoding tasks at two levels of learning (one versus three encoding trials). The encoding task and number of encoding trials were varied between subjects.

Procedure

Participants in the experiment were asked to perform either a predominantly item-specific encoding task or a predominantly relational encoding task. The level of learning was varied by asking some subjects to perform the encoding task one time and others to perform the encoding task three times.

Subjects were randomly assigned to one of four encoding conditions upon arrival at the laboratory. In one of the item-specific encoding conditions, faces were rated for distinctiveness one time and then the recognition test was given. In the other item-specific encoding condition, the encoding task was performed three times and then the test was given. In a similar manner the level of learning in the relational encoding condition was varied by number of encoding trials.

In the item-specific encoding condition, subjects were asked to rate each face for distinctiveness by placing the face on one of six numbered stacks labeled from one (Very Typical) to six (Very Distinctive). In the relational encoding condition, subjects were asked to sort the faces into six stacks based upon similarity, resemblance, or any other criteria that the subject might choose.

A set of 36 faces were presented during the encoding phase and a set of 72 faces were presented at test. Of these 72 faces presented at test, 26 were previously studied, ten conjunctive faces, and thirty-six entirely new faces. Subjects were asked to place each face on one of three stacks. If the face was presented at study, then the subject was asked to place the face in stack labeled “Old”. If the face was not presented at study, then the subject was asked to place the face on a stack labeled “New”. If the subject wished to hazard a guess that a face was studied, then the face was to be placed on the stack labeled “Guess”.

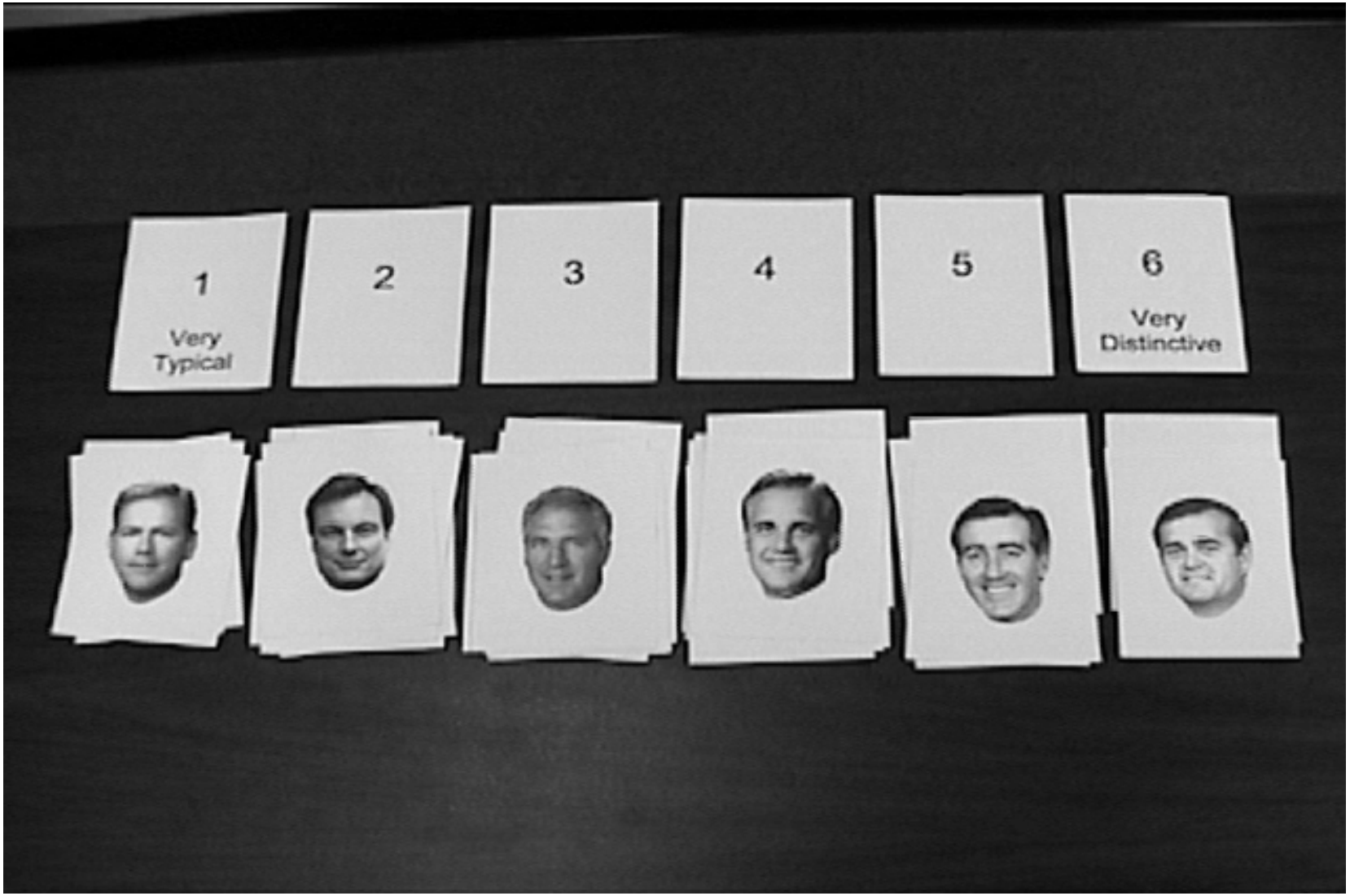

Figure 1. An Illustration of how the faces might be arranged after the item-specific encoding task.

Figure 2. An Illustration of how the faces might be arranged after the relational encoding task.

Results

An alpha level of .05 was used for all two-tailed statistical tests and a level of .10 was used for all one-tailed statistical tests.

Thirty-six faces were studied during the encoding phase. During the test phase twenty-six of the studied faces were presented along with ten conjunctions and 36 unstudied faces. Results for the selection of studied faces and conjunctions are shown in Table 1.

TABLE 1. Contrast of Item-Specific Processing (ISP) and Relational Processing (RP) at two levels of learning.

	Studied Faces	Studied minus Unstudied Faces (excluding conjunctions)	Accepted Conjunctions	Rejected Conjunctions
1 Encoding Trial				
ISP	14.1	3.6	2.5	6.8
RP	19.8	9.1	3.3	6.0
3 Encoding Trials				
ISP	21.9	16.1	2.6	6.6
RP	23.6	15.3	5.3	3.8

Studied faces. The encoding task produced an effect on the correct selection of studied faces [F(1,28) = 6.90, MSE = 15.75; p < .05]. The number of encoding trials also produced an effect on the selection of studied faces [F(1,28) = 17.16, MSE = 15.75; p < .001].

More studied faces were selected by subjects in the relational encoding condition than those in the item-specific encoding condition (22 versus 18). The encoding task did not produce any difference in the accuracy of face recognition based upon an analysis of studied faces minus unstudied faces.

Fewer studied faces were selected after one encoding trial than after three encoding trials (17 versus 23). Recognition accuracy also increased with study trials. The number of studied faces minus the number of unstudied faces increased from an average of 12 faces to 16 faces with an increase in the number of encoding trials [F(1,28) = 6.59, MSE = 18.23; p < 0.05].

Conjunctions. The encoding tasks produced different effects on the correct rejection of conjunction faces as well as incorrect selection of conjunctions. The item-specific encoding task supported greater rejection of conjunctions than the relational encoding task (6.7 versus 4.9) [F(1,28) = 6.52. MSE = 4.03; p < .05]. In a consistent manner, the encoding task also affected the incorrect selection of conjunction faces. Fewer conjunctions were selected by subjects in the item-specific encoding condition than those in the relational processing condition (2.6 versus 4.3) [F(1,28) = 5.11, MSE = 4.46; p < .05]. There was no discernable pattern in the selection of conjunction faces based upon guessing.

Guessing. The encoding task led to a general effect on correct guessing [F(1,28) = 6.58, MSE = 2.51; p <.05]. Subjects in the item-specific encoding condition made more correct guesses than subjects in the relational encoding condition (2.1 versus 0.7). This advantage was observed in the one encoding trial condition where item-specific encoding produced an advantage over relational encoding (3.0 versus 0.9) [F(1,14) = 4.61, MSE = 3.91; p <.05]. The direction of the effect was the same with three encoding trials (1.5 versus 0.5). However, the effect was not significant.

Effects with One Encoding Trial

Studied faces. Follow-up analysis showed that the encoding task affected the selection of studied faces in the one encoding trial condition [F(1,14) = 5.64, MSE = 22.46; p < .05]. More studied faces were selected by subjects in the relational processing condition than the item-specific encoding condition (20 versus 14). This effect did not extend recognition accuracy as measured by studied minus unstudied items (p ≅ .13).

Effects With Three Encoding Trials

Conjunctions. Follow-up analysis showed an effect for encoding task on the rejection of conjunction faces in the three encoding trials condition [F(1,14) = 5.83, MSE = 5.67; p < .05]. The item-specific encoding task led to the correct rejection of more conjunctions than the relational encoding task (6.6 versus 3.8). Follow-up analysis also showed an expected effect for encoding task on the incorrect selection of conjunction faces [F(1,14) = 4.22, MSE = 6.53; p < .06]. Fewer conjunctions were selected by subjects in the item-specific encoding condition than those in the relational processing condition (2.6 versus 5.3).

The ability of subjects in the item-specific encoding condition to reject conjunctions did not vary significantly as the level of learning was varied from one encoding trial to three encoding trials (6.8 versus 6.6). This is consistent with the expectation that item-specific processing involves the binding of the individual elements of a face into an individual item. Interestingly, the relational encoding condition produced a reduction in the ability of subjects to reject conjunctions after three encoding trials with respect to subjects performing the same encoding task just one time (6.0 versus 3.8) [$T(14) = 2.2$; $p < .05$].

Conclusion

With sufficient learning (three encoding trials) the predominantly Item-Specific Processing (ISP) encoding strategy supported binding to a greater extent than the predominantly Relational Processing (RP) encoding strategy. This conclusion is consistent with the expectation that item-specific processing supports the activity of binding the elements of a face; such as the eyes, nose, mouth, and hair into a single item.

At a lower level of learning (one encoding trial) the ability of subjects to reject conjunctions was quite similar regardless of encoding task. This is consistent with the expectation that a large amount of item-specific processing must be performed in the initial stages of a predominantly between-item relational processing encoding task in order to provide the basis for distinguishing one face from another. The ability to reject conjunctions at a low level of learning by subjects in the predominantly item-specific encoding condition is consistent with the postulated activity of within-item relational processing on the part of subjects engaged in the item-specific encoding task.

Discussion

Face encoding is a complex process that involves scanning from one element of the face to another and the combination of this detailed information in memory (Kandel, 1991; Matthews, 1978; Reinitz, Morrisey, & Demb, 1994). Face encoding, like any other memory formation process, can be modeled as the result of two primitive processes of cognition. The interaction of these two processes is shown as a state diagram in Figure 1. Information for memory storage may be supplied by Item-Specific Processing (ISP) or Relational Processing (RP).

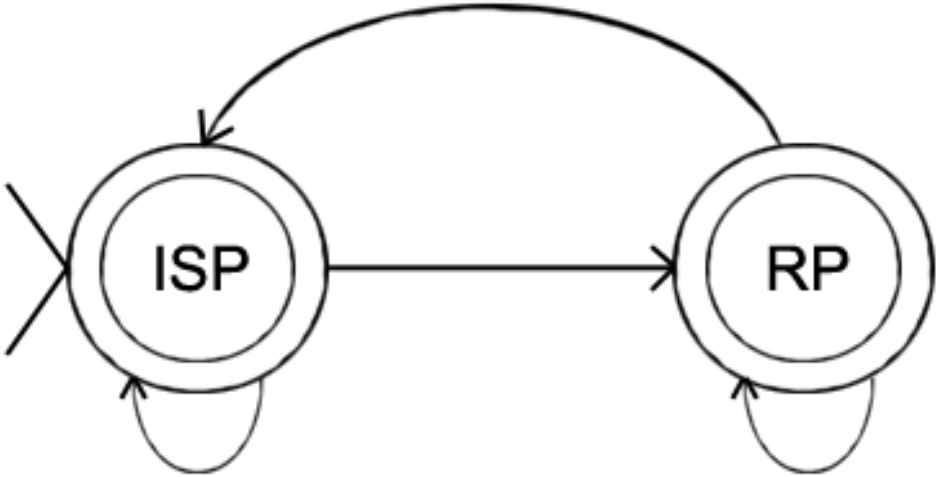

Figure 1. State Diagram of Memory Formation Activity. Memory formation begins with one or more iterations of Item-Specific Processing (ISP) followed by zero or more iterations of Relational Processing (RP). This activity may be repeated.

The encoding of individual faces can be disrupted by artificial means such as the overlay of focus dots on adjacent faces during encoding. This sort of disruption reduces the ability of subjects to reject conjunctions (Reinitz & Hannigan, 2001). However, under normal viewing conditions the ability to reject conjunctions remains intact into old age (Searcy, Bartlett, & Memon, 1999).

Item-specific processing provided an advantage over relational processing with increased levels of study. With three encoding trials, subjects in the item-specific encoding condition rejected more conjunctions (66%) than those in the relational encoding condition (38%). The increased ability to reject conjunctions by the item-specific encoding group occurred in light of a general increase in the selection of studied faces and recognition accuracy with repeated encoding trials.

The rejection rates obtained in the current study are consistent with those observed in other research with undisrupted encoding experiences. Searcy, Bartlett, & Memon (1999) noted conjunction rejection rates of 61% for young adults and 60% for old subjects that did not have perceptual deficits. These rates are consistent with results obtained for subjects in the relational encoding condition with one encoding trial (60%) and are somewhat similar to rates obtained for subjects in the item-specific encoding condition with one encoding trial (68%).

The pattern of results obtained in this study is consistent with the hypothesis that a high degree of within-item relational processing occurs in the early stages of the predominantly item-specific encoding task. Additionally, the pattern of results are consistent with the hypothesis that item-specific processing continues through three encoding trials for subjects in the predominantly item-specific encoding condition but diminishes for subjects in the relational encoding condition.

References

Epling, G.A. (2000) The Roles of Relational Processing and Item-Specific Processing in Remembering and Knowing Faces. Unpublished doctoral dissertation, University of Texas, Dallas.

Epling, G.A. & Bartlett, J. C. (2000) Remembering and Knowing Faces Based Upon Primitive Processes of Cognition Poster session presented at the annual meeting of the American Psychological Society, Miami, FL. (Available: http://www.mindjava.com)

Kandel, E. R. (1991) Perception of Motion, Depth, and Form. In E.R. Kandel, J.H. Schwartz, & T.M. Jessell [Eds.] *Principles of Neural Science, 3rd Edition* (440-466). New York, N.Y.: Elsevier.

Mäntylä, T. (1997) Recollections of Faces: Remembering Differences and Knowing Similarities. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23, 1203-1216.

Matthews, M.L. (1978) Discrimination of Identikit constructions of faces: Evidence for a dual processing strategy. *Perception and Psychophysics*, 23, 153-161.

Reinitz, M.T., Morrisey, J., & Demb, J. (1994) Role of Attention in Face Encoding. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 20, 161-168.

Reinitz, M. T. & Hannigan, S. L. (2001) Effects of simultaneous stimulus presentation and attention switching on memory conjunction errors. *Journal of Memory & Language*. 44, 206-219.

Searcy, J., Bartlett, J.C., & Memon, A. (1999) Age differences in accuracy and choosing in eyewitness identification and face recognition. *Memory & Cognition*. 27, 538-552.

NOTE

Pilot studies that supported this effort were performed at Collin County Community College in Plano, Texas. The author thanks Drs. Martha Ellis and Bill Adler of Collin County Community College for the opportunity to enlist subjects from their classes and the use of laboratory resources. The author also thanks Drs. Bert Moore and James Bartlett for the opportunity to draw upon the pool of available subjects at University of Texas at Dallas and the use of laboratory resources.

Gerald Epling may be contacted at: epling@mindjava.com