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A New Perspective on Remembering and Knowing Faces

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Abstract

The currently dominant account of recognition memory contends that recognition derives from a single ergodic process. An alternative account of recognition memory suggests that important distinctions exist between two primitive processes of cognition, item-specific processing and relational processing. Item-specific processing promotes the development of distinctiveness for individual items and relational processing supports the organization of items in memory. These two primitive processes of cognition differentially affect the production of subjective judgments of knowing and remembering. Knowing refers to familiarity without associating a recognized item with any particular event or experience. In contrast, remembering refers to becoming aware again of events or experiences associated with an earlier presentation of stimuli. In experiment one, item-specific processing is linked with knowing and relational processing is linked with remembering. In experiment two, repeated performance of an item-specific encoding task is shown to provide and advantage over relational processing in the ability to reject unstudied faces.

A New Perspective on Remembering and Knowing Faces

In 1985 Tulving introduced a distinction between two subjective states of conscious experience that has yet to be fully explained. Perhaps it is time for a new perspective on this distinction between states of consciousness? As a prelude to the introduction of a new perspective, it is important to briefly review how these two states of consciousness awareness are identified and to consider the current state of research aimed at explaining this difference.

Tulvings' two states of conscious awareness are identified by subjective judgments of “knowing” and “remembering”. To “know” is to recognize or recall a studied item without conscious awareness of the original stimulus presentation. In contrast, recollection with conscious awareness of the learning event is termed “remembering”. Remembering might bring to mind a particular association, something about the appearance of the studied item, an image, or the position of the item in the presentation sequence (Tulving, 1985; Gardiner, 1988).

Convincing evidence for the dissociation of remember and know judgments has been presented in recognition studies by Gardiner and colleagues (Gardiner & Richardson-Klavehn, 2000). These studies show that remember judgments can vary with know judgments remaining constant (Gardiner, 1988; Gardiner & Java, 1990; Gardiner & Java, 1991; Gardiner & Parkin, 1990), know judgments can vary without corresponding changes in remember judgments (Gregg & Gardiner, 1994), and concurrent increases in both remember and know judgments can be obtained (Gardiner, Kaminska, Dixon, & Java, 1996).

Some equally compelling changes in the patterns of remember and know judgments have been obtained by repetition of items during study presentations. In a recent study of the effect of massed versus spaced repetition of words, Dewhurst and Anderson (1999: experiment 1) found that spaced repetition produced higher levels of remember judgments than massed repetition of study items. In a related study from the domain of face recognition, spaced repetition again exceeded massed repetition in the production of remember judgments while massed repetition exceeded spaced repetition in the production of know judgments (Parkin, Gardiner, & Rosser, 1995).

The novelty of stimuli is also an important factor in the production of remember and know judgments. In a music recognition study, Gardiner, Kaminska, Dixon, and Java (1996) found that repeated presentation of culturally familiar music produced an increase in remember judgments with no increase in know judgments. In the same study, it was noted that repeated presentation of culturally unfamiliar music resulted in a parallel increase in remember and know judgments. Potentially confounding factors, such as a unique aspects of English or Polish music, or some unexpected attribute of English people were eliminated in a later study where the effect was replicated with Polish participants using selections of English and Polish folk music (Gardiner & Radomski, 1999). Results suggest that the lack of familiarity for a musical genre was the critical factor in producing parallel increases in remember and know judgments with the repeated presentation of culturally unfamiliar music. These studies demonstrate that learning, as well as novelty of stimuli, has a strong influence on the production of remember and know judgments (Gardiner & Conway, 1999).

Recent attempts to identify the processes behind the production of remember and know judgments have considered the effects of conceptual versus perceptual processing (Rajaram & Roediger, 1997), distinctiveness and fluency of processing (Rajaram, 1999), conscious versus unconscious processing (Jacoby, 1991; Jacoby, Jennings, & Hay, 1996), and variation in criteria for acceptance or rejection of test items (Donaldson, 1996). However, no existing account handles all of the findings (Richardson-Klavehn, Gardiner, & Java, 1996; Rajaram & Roediger, 1997).

Several counter-examples to the conceptual/perceptual processing account have been reported (Rajaram, 1996; 1998; 1999). In place of the conceptual/perceptual approach, a distinction between distinctiveness and fluency of processing has been suggested (Rajaram, 1996; 1998; 1999; Rajaram & Roediger, 1997). In the conceptual/perceptual approach the distinctiveness of stimuli is assumed to give rise to remember judgments and fluency of processing, both conceptual and perceptual, is tied to know judgments. Based upon the observation that distinctive stimuli garner more remember judgments, it could be argued that distinctiveness processing should also facilitate the production of remember judgments (Rajaram, 1998). An understanding of the processes that underlie this facilitation would be beneficial.

In another line of research, Mäntylä (1997) compared the effect of distinctiveness rating with category sorting. Mäntylä concluded that distinctiveness rating, a task assumed to promote item-specific processing, facilitated the production of remember judgments and that category sorting facilitated the production of know judgments. Category sorting is assumed to promote relational processing. These findings present an important conflict in the literature. There are good reasons to expect item-specific processing to lead to increased levels of know judgments and for relational processing to lead to increased levels of remember judgments.

Item-specific processing is assumed to promote the development of distinctiveness in memory (Hunt, 1995). According to the distinctiveness hypothesis, distinctive items are better retained than less distinctive items (Ellis & Hunt, 1989). In a study of memory persistence, Gardiner and Java (1991) found that recognition based upon subjective judgments of knowing did not decline as rapidly as recognition based upon remembering. The expectation of increased retention of distinctive items is consistent with a slower decline of memory associated with know judgments observed by Gardiner and Java (1991). This suggests a link between item-specific processing and subjective judgments of knowing, a prediction that is in conflict with Mäntyläs' (1997) observation of higher levels of know judgments with a category sorting task than with a distinctiveness rating task.

There is an intriguing possibility for the conflict between Mäntyläs' (1997) empirical findings and expectations based upon the verbal literature of item-specific processing and relational processing. It is possible that the encoding tasks did not preferentially engage item-specific processing and relational processing as intended. Participants in Mäntyläs' (1997) study viewed each face just one time. Earlier studies have shown that multiple presentations are often required for the stable organization of stimuli in memory (Tulving, 1962; Mandler, 1967; 1980; Mandler, Pearlstone, & Koopmans, 1969). So, it is reasonable to expect an amplification of the relational processing strategy with repeated encoding trials with a category sorting task. In order to investigate this possibility, the level of organization in the study materials must be varied. Because the need to vary the study lists is not obvious, the premise will be developed.

Sometimes there is an advantage in combining an encoding task with a study list (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993). When an item-specific encoding task is contrasted with a relational encoding task using an organized study list, then an advantage over relational processing may be seen in hit minus false alarm rates. Additionally, a relational encoding task can produce an advantage over an item-specific encoding task with an unorganized study list. The advantage for a relational processing encoding task over an item-specific processing encoding task with an unorganized study list is due in part to the high degree of individual item processing that is required just to be able to differentiate one item from the next. Combining item-specific processing with an unorganized list is redundant and leaves little advantage to the item-specific encoding condition. The complementary information that is needed with an unorganized list is organizational. The advantage for relational processing with an unorganized study list often requires multiple encoding trials to become manifest.

With one encoding trial, item-specific processing typically produces an advantage over relational processing when the study list is organized (Einstein & Hunt, 1980; Hunt & Einstein, 1981). When the study list is not organized, then hit minus false alarm rates are often the same for both the relational encoding task and the item-specific encoding task with one encoding trial. In Mäntylä's (1997) study there was no effect for encoding task on overall recognition. This suggests that the study lists lacked any apparent organization. Without a comparison between two study lists with different levels of apparent organization, it is not possible to establish the complementary activity between encoding task and study list. In order to observe the complementary effect of encoding task and study list in the current experiment, two different study lists with two different levels of organization were used.

When the level of learning is varied by the contrast of a single encoding trial with three encoding trials, then the following predictions may be made regarding the production of remember and know judgments.

1. With sufficient learning, item-specific processing will produce a predominance of know judgments.
2. With sufficient learning, relational processing will produce a predominance of remember judgments.
3. If a face appears to be distinctive, then relational processing will be preferentially engaged.
4. If a face appears to be typical, then item-specific processing will be preferentially engaged in order to develop distinctiveness in memory for the face.

Experiment 1

Method

Participants. Sixty-four University of Texas at Dallas undergraduate students participated and received partial fulfillment of a course requirement. Subjects were randomly assigned to one of the four study groups based upon order of arrival at the laboratory.

Design and Materials. The experiment employed a 2 (one versus three encoding trials) x 2 (item-specific versus relational encoding) x 2 (heterogeneous versus homogeneous study list) design. The heterogeneous study list was an organized list. The homogeneous list was not organized. List structure was varied within subjects. All subjects encoded one heterogeneous list and one homogenous list. The number of encoding trials and encoding conditions were varied between subjects.

Portrait style images of faces were used in the experiment. Faces were rendered in 256 shades of gray on index card stock measuring four and a quarter by five and a half inches. Each image was edited to show just the head and part of the neck. Faces were about three and one-half inches tall, subtending a nine degree visual angle at twenty-two inches.

In order to examine the potential interaction between encoding task and the organization of study lists, two different sets of faces were formed. One set was an unorganized, homogenous set containing the faces of 72 middle-aged men with average length hair. The organized, heterogeneous set contained 72 faces with six different subsets of 12 faces each. Faces in the heterogeneous set were selected based upon sex and hairstyle. Half of the faces in the heterogeneous set were women's faces and half were men's faces. Faces of women with short, medium, and long hair were used to make three different subsets of female faces. Faces of men with no hair, medium length hair, and bushy hair were used to make three different subsets of male faces. Each set of 72 faces was divided into equal parts. This allowed for the presentation of one study list of 36 faces during the encoding trial and the presentation of 36 faces from a similar list along with the studied faces during test.

All participants studied one 36-item homogeneous list and one 36-item heterogeneous list of faces. The order of list presentation was counterbalanced, so that half of the subjects saw a homogenous study list first and half saw a heterogeneous list first. All possible permutations of these lists, that produce an ordered pair of different types of list, were used in the experiment. Therefore, there were 8 different presentation orders for the 4 different lists that were used in the experiment [P(4,2) – 4]. All unique orderings of the study lists were used twice in each of the four different encoding conditions of the experiment.

Procedure. Subjects were assigned to one of four encoding conditions based upon arrival at the lab. Subjects performed either one encoding trial or three encoding trials with either a relational encoding task or a distinctiveness encoding task. In the relational encoding conditions, faces were sorted into six stacks based upon similarity. It was suggested that faces might be considered to be similar based upon resemblance, personality, expression, or any six criteria that the subject cared to choose. In the distinctiveness encoding conditions, faces were sorted into six different stacks based upon the perceived distinctiveness of the individual faces. The scale for distinctiveness ranged from very typical to very distinctive. Participants were taken individually and allowed to proceed at their own pace. Study time and test time were measured and recorded. The encoding instructions in all conditions stated that there would be a recognition test after the encoding task.

During the testing phase, subjects were asked to determine if a given face was a studied item or if it was a new item. If the face was a studied item, then the subject was to determine the basis of recognition. Test responses were made by placing faces onto one of four stacks. The stacks were identified by place cards labeled “New”, “Know”, “Remember”, and “Guess” (Gardiner, Richardson-Klavehn, & Ramponi, 1997). All of the studied faces plus an equivalent number of new faces were randomly intermingled for presentation at test. Eight people were dropped from the study without examining their responses. Two of these subjects could not sort the faces in the required time. The remaining six subjects failed to follow instructions.

Results

The results are divided into two sections. In the first section, the complementary effect of encoding task and study list on recognition is considered. In the second section, the dependence of recognition on encoding task and distinctiveness of stimuli is considered. An alpha level of .05 was used for all statistical tests.

In the first section the effect of encoding task, study list, and number of encoding trials are modeled as independent variables influencing memory formation as measured by overall recognition, remember judgments, know judgments, and guess judgments.

Overall Recognition. The interaction between list structure and encoding task is shown in Table 1. The item-specific encoding task produced an advantage over the relational encoding task with one encoding trial and a relatively organized, homogeneous study list (.50 versus .35). With one encoding trial and a homogenous study list, scores were similar for both encoding tasks (.51 versus .51).

Insert Table 1 about here.

The relational encoding task produced an advantage over the item-specific encoding task with the less organized, homogeneous study list after three encoding trials as measured by overall recognition (.81 versus .65). With the heterogeneous list, scores were similar after three encoding trials regardless of encoding task.

This pattern of results was supported with a three-way ANOVA. Results, presented in Table 2, show that encoding task reliably interacted with study list. The interaction between encoding task and study list organization is consistent with the expectation of a complementary effect of encoding task and list organization (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993). Nevertheless, in an earlier review of this work, it was suggested that any putative advantage for an encoding task with any particular study list can be attributed to an increase in time spent encoding the study list and cannot be rightly attributed to the encoding task.

Insert Table 2 about here.

In order to address the question of time spent encoding study lists, an analysis was performed on the time subjects spent encoding these lists. Additionally, an analysis of the time spent testing was performed in order dispel any notion that the time subjects spent in the test phase might be a predictor of recognition measures used in this study.

Time Expended in Encoding. The amount of time spent encoding faces might be a predictor of subsequent recognition of faces. In particular, the effects of study list on recognition accuracy as measured by overall Hit minus False Alarm (H-FA) scores and by H-FA scores for “remember” judgments, “know” judgments, and guessing might reflect differences in encoding time. During the pilot studies, subjects mentioned that encoding the homogeneous study list was more difficult than encoding the heterogeneous study list. This increased difficulty could result in an increase in the amount of time spent encoding faces from the homogeneous study list as compared to the heterogeneous study list. To assess this possibility, the amount of time subjects spent encoding faces was subjected to an ANOVA including encoding task, study list, and number of encoding trials. There was an unsurprising significant effect for the number of encoding trials on the amount of time spent encoding a study list [$F(1,60) = 88.78$, $p < .0001$]. Performing an encoding task three times took longer than performing an encoding task just one time (8.9 minutes versus 3.9 minutes). There was also an effect for study list [$F(1,60) = 13.68$, $p < .001$]. The average time to encode a homogeneous study list was 7.0 minutes whereas the average time to encode a heterogeneous study list was 5.8 minutes. The effect for study list was qualified by an interaction with the number of encoding trials [$F(1,60) = 4.31$, $p < .05$]. This interaction is shown in Table 3.

Insert Table 3 about here.

Follow-up analyses were performed in order to examine the interaction between study list and number of encoding trials. Analysis of encoding time showed no significant effect for study list with one encoding trial. However, with three encoding trials, there was a significant effect for study list. It took people longer to perform three encoding trials with a homogeneous study list than to perform three encoding trials with a heterogeneous study list (9.9 minutes versus 7.9 minutes) [$F(1,30) = 11.93$, $p < .01$].

While it is true that causality cannot be inferred from a correlation analysis, such an analysis could be informative by showing that certain variables do not correlate with one another. In order to further consider the possibility that time spent encoding a study list might explain the difference in study lists, a correlation study was performed. There was no reliable correlation between time spent encoding and any of the memory measures.

<u>Time Expended in Testing</u>. No effects were expected for the amount of time spent performing recognition tests. However, the possibility of an effect for time spent testing was considered and these times were recorded. Three-way ANOVA of time spent testing showed no significant effects or interactions.

Remember and Know Judgments. The pattern of results for correct remember, know, and guess judgments is shown in Figure 1. Notice that with one encoding trial, remember judgments were greater in the distinctiveness encoding condition than in the relational encoding condition and know judgments were greater in the relational encoding condition than in the distinctiveness encoding condition. With three encoding trials this pattern of results was reversed.

Insert Figure 1 about here.

Remember Judgments. The pattern of results for correct remember judgments was supported with a three-way Analysis of Variance (ANOVA) modeling the factors of encoding task, study list, and number of encoding trials. The category sorting task produced more remember judgments than distinctiveness rating task (.48 versus .37). This effect was qualified by a crossover interaction between the encoding task and the number of encoding trials. With one encoding trial, more remember judgments were obtained with the distinctiveness rating task than with the category sorting task. With three encoding trials the effect of encoding task on the production of remember judgments was reversed.

Follow-up analyses showed that the effect due to encoding task was significant after one encoding trial [$F(1,30) = 5.49$, $p < .05$] and again after three encoding trials [$F(1,30) = 59.22$, $p < .0001$].

Know Judgments. The pattern of results for correct know judgments was supported with a three-way ANOVA. There was a main effect for encoding task, more know judgments were made with the distinctiveness rating task than with the category sorting task (.38 versus .28). The effect due to encoding task was qualified by an interaction with the number of encoding trials. The pattern of results obtained for the encoding tasks with one encoding trial was reversed after three encoding trials.

Follow-up analyses showed a reliable effect for encoding task with one encoding trial [$F(1,30) = 7.71$, $p < .01$] and with three encoding trials [$F(1,30) = 61.12$, $p < .0001$]. With one encoding trial, the category sorting task produced higher levels of know judgments than the distinctiveness rating task (.37 versus .23). In contrast, with three encoding trials, the distinctiveness rating task produced higher levels of know judgments than the category sorting task (.53 versus .19).

Guesses. Correct guessing rates were slightly greater for the homogeneous study list than for the heterogeneous study list (.08 versus .06). This pattern of results for correct guesses was supported with a three-way ANOVA [$F(1,60) = 10.30$, $p < .01$]. Analysis of Hit minus False-Alarm (H-FA) rates for guesses showed that studied items were not distinguished from non-studied items by guessing. H-FA scores for guesses were all close to zero and were not analyzed further.

The Recognition Model. The model of recognition that is tested in the following analysis is based upon encoding task, distinctiveness of stimuli, and number of encoding trials. The factor of study list from the previous model is replaced with two levels of distinctiveness. Replacing study list with distinctiveness in this framework does not alter any of the previously reported results for simple effects of encoding task or encoding trials. Nor is the reported interaction between encoding task and encoding trials altered.

During the course of the experiment, each of the four sets of faces were rated for distinctiveness on a six-point scale by 16 subjects. Distinctiveness ratings for the homogeneous lists were 3.16 and 3.36. Distinctiveness ratings for the heterogeneous lists were 3.23 and 3.24. Standard deviations were 0.49, 0.68, 0.70, and 0.84, respectively. In order to examine the effect of face distinctiveness on the production of remember and know judgments, a median split was made within the set of all homogeneous faces and within the set of all heterogeneous faces. These two levels of face distinctiveness then served as an independent variable in the following analysis of recognition.

The recognition model under consideration is a 2 (item-specific versus relational encoding) x 2 (distinctive versus typical faces) x 2 (one versus three encoding trials) design. The current model of recognition features fewer interactions than the model based upon encoding task, study list, and encoding trials. Specifically, there is no interaction between distinctiveness and encoding task and there is no interaction between distinctiveness and encoding trials. Results of this analysis are shown in Table 4. The effectiveness of this model in predicting various measures of recognition is represented in Table 5.

<u>Remember Judgments.</u> Analysis of correct remember judgments showed an effect for distinctiveness. More correct remember responses were given for distinctive faces than for typical faces (.25 versus .18). This result was replicated with H-FA scores for remember judgments (.21 versus .15).

Follow-up analyses showed that the effect due to distinctiveness was significant after one encoding trial (.23 versus .16) [$F(1,30) = 17.24$, $p < .001$] and again after three encoding trials (.27 versus .19) [$F(1,30) = 37.02$, $p < .0001$]. Regardless of the number of encoding trials, distinctive faces garnered more remember judgments than typical faces.

The effect of face distinctiveness on the production of remember judgments is consistent with the expectation that relational processing is preferentially engaged when the stimuli are perceived to be distinctive.

Know Judgments. Distinctiveness was a significant factor in the production of correct know judgments. More correct know responses were given for typical faces than for distinctive faces (.18 versus .15). However, this effect was not replicated with H-FA scores for know judgments.

Follow-up analyses showed that with one encoding trial, distinctive faces produced lower levels of know judgments than typical faces (.14 versus .17) [$F(1,30) = 7.33$, $p < .05$]. With three encoding trials, distinctiveness of stimuli failed to produce a significant effect on the production of know judgments.

The effect of face distinctiveness on the production of know judgments is consistent with the expectation that item-specific processing is preferentially engaged when stimuli are perceived to be typical.

Guesses. Correct guessing rates were slightly higher for distinctive faces than for typical faces (.04 versus .03). This pattern of results for correct guesses was supported with a three-way ANOVA [$F(1,60) = 16.38$, $p < .001$]. Analysis of Hit minus False-Alarm (H-FA) rates for guesses showed that studied items were not distinguished from non-studied items by guessing. H-FA scores for guesses were all close to zero and were not analyzed further.

Overall Recognition. Analysis of overall recognition as measured by hits minus false-alarms showed an advantage for distinctive faces over typical faces (.30 versus .26).

Follow-up analysis showed no significant effect of face distinctiveness on the H-FA rates with one encoding trial or with three encoding trials.

False Remember Judgments. Analysis of false remember judgments showed an effect for the number of encoding trials [$F(1,60) = 5.18$, $p < .05$] and an interaction between encoding task and face distinctiveness [$F(1,60) = 4.31$, $p < .05$]. Fewer false alarms were made after three encoding trials than after one encoding trial (.03 versus .06). There was a crossover interaction between encoding task and face distinctiveness. With item-specific encoding fewer false-alarms were made for typical faces than for distinctive faces (.03 versus .04). In the relational encoding condition, fewer false-alarms were made for distinctive faces than for typical faces (.03 versus .04).

Follow-up analysis of incorrect remember judgments showed an interaction between encoding task and face distinctiveness with one encoding trial [$F(1,30) = 4.35$, $p < .05$]. The interaction was a crossover interaction, similar to that observed in the overall analysis. With the item-specific encoding task, fewer false-alarms were made for typical faces than for distinctive faces (.03 versus .06). With the relational encoding task, fewer false-alarms were made for distinctive faces than for typical faces (<.04 versus >.04).

False Know Judgments. The number of encoding trials had an effect on the production of false know judgments [$F(1,60) = 4.24$, $p < .05$]. False know judgments were less frequent with three encoding trails than with one encoding trial (.05 versus .07). The effect for the number of encoding trials was qualified by an interaction between number of encoding trials and encoding task [$F(1,60) = 4.24$, $p < .05$]. Reductions in false alarms with increased levels of learning were not uniform between encoding conditions. In the relational encoding condition, fewer incorrect know judgments were observed with three encoding trials than with one encoding trial (.05 versus .09). In the item-specific encoding condition, incorrect know judgments were the same with one encoding trial and with three encoding trials (.05).

Follow-up analysis showed no interaction between the number of encoding trials and encoding task. However, with one encoding trial fewer incorrect know judgments were made in the item-specific encoding condition than in the relational encoding condition (.05 versus .09).

False Guess Judgments. Face distinctiveness had an effect on the production of incorrect guesses [$F(1,60) = 5.79$, $p < .05$]. Fewer incorrect guesses were made for distinctive faces than for typical faces (.04 versus .05).

Overall False-Alarms. Fewer false alarms were made after three encoding trials than after one encoding trial (.11 versus .16) [$F(1,60) = 9.27$, $p < .005$]. The effect for the number of encoding trials was qualified by an interaction with encoding task. The decrease in false alarms between one encoding trial and three encoding trials was greater in the relational encoding condition (.17 versus .09) than in item-specific encoding condition (.14 versus .13) [$F(1,60) = 9.27$, $p < .005$].

Conclusion

Two different study lists were used in this experiment in order to validate the encoding tasks. This validation was established by the interaction between study list organization and encoding task. At low levels of learning with a relatively organized study list, the item-specific encoding task produced higher hit minus false alarm rates than the relational encoding task (.50 versus .35). This pattern of results is consistent with research from the verbal literature.

The relative advantage for the relational encoding task was observed at higher levels of learning. With three encoding trials there was a reliable interaction between encoding task and level of study list organization. The complementary effect of encoding task and the level of study list organization was seen as an advantage for the relational encoding condition over the item-specific encoding condition with an unorganized, homogeneous study list. With three encoding trials, hit minus false alarm rates were higher in the relational encoding condition than in the item-specific encoding condition with an unorganized study list (.81 versus .65). In the verbal literature, the advantage for relational processing over item-specific processing is usually measured by cluster analysis of recall test responses. This approach is not possible with recognition testing. So, hit minus false alarms were analyzed in place of clustering.

Taken together, the effects of encoding task and study list organization provide support for Mäntyläs' (1997) selection of distinctiveness rating as an item-specific encoding task and category sorting as a between-item relational encoding task. Mäntyläs' results regarding the production of remember and know judgments were replicated in the one encoding trial condition and reversed with three encoding trials. This suggests that there are some fundamental differences in the combination of primitive processes that are engaged with one encoding trial and three encoding trials with the given encoding tasks in the current study.

An earlier review of this work challenged the validity of the encoding task and study list variations by suggesting that differences associated with different encoding tasks and different study lists are most likely explained by the amount of time spent encoding the study lists. This was shown not to be the case.

By using two levels of study list organization, a link was established between the verbal literature and the current face recognition study. Additionally, the encoding tasks were shown to be effective tools for engaging item-specific processing and relational processing at higher levels of learning. However, the production of remember and know judgments is not well modeled by the influences of encoding task, number of encoding trials, study list, an interaction between the encoding task and study list, and an interaction between encoding trials and study list. The relative contributions of each of these variables as measured by η^2 are 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.

An improved model of the factors affecting the production of remember and know judgments in the current study was presented in the results section of experiment one. This model was based largely on the effects of encoding task and the distinctiveness of stimuli. The improved model accounts for 76% or more of the variance for remember and know judgments observed in experiment one. This model also accounts for 78% or more of the variance in the one encoding trial condition and the three encoding trials condition.

Expectations associated with the encoding tasks were support by the results of experiment one. With three encoding trials, item-specific processing produced a predominance of know judgments and relational processing produced a predominance of remember judgments.

Face distinctiveness was a significant factor in the production of remember judgments. Regardless of the number of encoding trials, distinctive faces garnered more remember judgments than typical faces. This effect was ubiquitous and consistent with the expectation that relational processing is preferentially engaged when stimuli are perceived to be distinctive.

Face distinctiveness was also a significant factor in the production of correct know judgments in the overall analysis. However, the effect of distinctiveness on the production of correct know judgments was restricted to the one encoding trial condition. Face distinctiveness did not produce a significant effect on hit minus false alarm rates for know judgments. The observed effect of face distinctiveness on the production of correct know judgments is consistent with the expectation that item-specific processing is preferentially engaged when stimuli are perceived to be typical.

Discussion

Before considering the implications of a dual processing explanation of recognition memory, it is important to consider the suggestion that remember and know judgments are best explained by a single process approach (Donaldson, 1996).

One such approach suggests that know judgments are the result of a variation in criteria for identifying a studied item. In this approach, any variable that affects remember judgments should also affect know judgments in the same way (Donaldson, 1996). A strong prediction based on this single process approach is that A´ values for remember judgments will not vary significantly from the A´ values of remember and know judgments combined (Donaldson, 1996). This was demonstrated not to be the case in a few studies where low levels of remember judgments were present in responses (Gardiner & Gregg, 1997). The results obtained in the current study provide another counter example to the suggestion that A´ values for the combination of remember and know judgments will not significantly differ from A´ values for remember judgments. Notice that the A´ values, shown in Table 6, for remember judgments are significantly different from the A´ values for the combination of remember and know judgments.

Insert Table 6 about here.

The role of face distinctiveness in facilitating the production of remember judgments is consistent with the distinctiveness/fluency of processing approach (Rajaram, 1998). However, the effect of face distinctiveness does not entirely parallel the effect of the distinctiveness rating encoding task in the current study. With three encoding trials distinctiveness rating produced more know judgments than remember judgments.

Reconciliation of the divergence between the effects of distinctive stimuli and distinctiveness rating at higher levels of learning is found in the complementary aspect of organization and distinctiveness (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993). When distinctive information is presented for encoding, then there is little need to engage item-specific processing. With the attainment of distinctiveness in memory the encoding emphasis shifts from item-specific processing to relational processing. In this account the dominance of remember judgments for distinctive faces is attributed to relational processing. This explanation of remember judgments as the result of relational processing is contingent upon the fact that no encoding task is process pure. At best, an encoding task can only engage one primitive process to a greater extent than the complementary process.

Beyond the engagement of relational processing by distinctive stimuli, there is the matter of a predominance of remember judgments produced in the early stages of the item-specific encoding task. The claim that an item-specific encoding task preferentially engages relational processing in the initial stages may seem strange until one considers the complexity involved in encoding a human face. The elements that make up a unique face are spaced far enough apart to require a lot of eye movement during the encoding process. The average sized face used in the current study subtended a visual angle of about 9 degrees, while the area of the eye that best distinguishes detail subtends only a 3 degree visual angle. This means that the encoding of the eyes would have to proceed separately from the encoding of the chin, or the hairline, or the nose. These elements of the face must be pieced together in memory (Kandel, 1991; Matthews, 1978). This binding of the elements of a face together is within-item relational processing. So, it is not unusual to see a majority of remember judgments in the early stages of an item-specific encoding task. These remember judgments are the result of within-item relational processing.

The effect of face typicality on the production of know judgments with one encoding trial combined with the lack of an effect for face typicality on the production of know judgments with three encoding trials suggests that the effect of face typicality is reduced at higher levels of learning. Increases in overall recognition were observed for both encoding conditions when the level of learning was increased, suggesting that learning continued in both encoding conditions.

It is possible that increases in between-item relational processing, associated with repeated category sorting, require little additional item-specific processing while focusing attention on similarities between faces. In contrast, increases in item-specific processing associated with repeated distinctiveness rating maintains the focus on individual faces. This should lead to an advantage for the item-specific encoding condition over the relational encoding condition with respect to the ability to reject a non-studied face that closely resembles a studied face. This potential advantage for distinctiveness rating over category sorting with repeated encoding trials can be tested with a special type of lure that is known as a conjunction. A conjunction is formed by taking the eyes and nose from one studied face and exchanging them with the eyes and nose of another studied face. This produces a class of lures that are very similar to studied faces.

Experiment 2

Method

The method used in experiment two was similar to that employed in experiment one. The encoding tasks remained the same. Differences between experiment one and experiment two include the use of a single homogeneous study list rather than two study lists. Additionally, the recognition test did not include remember or know judgments. Conjunctions were presented at test. The number of subjects in each encoding condition was reduced to eight.

Participants. Thirty-two University of Texas at Dallas undergraduate students participated in partial fulfillment of a course requirement. Subjects were randomly assigned to one of the four study groups based upon order of arrival at the laboratory.

Design and Materials. The experiment employed a 2 (item-specific versus relational encoding) x 2 (one versus three encoding trials) design. The encoding tasks and number of encoding trials were varied between subjects. Two sets of 36 faces from the previous experiment were used in this experiment. Both sets were unorganized or homogeneous. Each set served alternatively as a study list and as unstudied lures for the recognition test. Ten of the studied faces in each list were altered for the recognition test by exchanging the eyes and nose from one face with the eyes and nose of another face. In this manner, conjunctions were formed form the elements of studied faces. Each recognition test featured 10 conjunction faces, 26 studied faces, and 36 unstudied faces.

Procedure. Subjects were assigned to one of four encoding conditions based upon arrival at the lab. Subjects performed either one or three encoding trials with either a relational encoding task or a distinctiveness encoding task. In the relational encoding conditions, faces were sorted into six stacks based upon similarity. It was suggested that faces might be considered to be similar based upon resemblance, personality, expression, or any criteria that the subject cared to choose. In the distinctiveness encoding conditions, faces were sorted into six different stacks based upon perceived distinctiveness of the individual faces. The scale for distinctiveness ranged from very typical to very distinctive. Participants were taken individually and allowed to proceed at their own pace. The encoding instructions in all conditions stated that there would be a recognition test after the encoding task.

During the testing phase, subjects were asked to determine if a given face was a studied item or if it was a new item. If the face was a studied item, then the subject was to determine the basis of recognition. Test responses were made by placing faces onto one of three stacks. The stacks were identified by place cards labeled “Old”, “New”, and “Guess”. Subjects were asked to place faces that were presented at test in the stack labeled “Old”. Unstudied faces were to be placed in the stack labeled “New”. If a subject cared to hazard a guess that a face might have been studied then they were to place the face in the stack labeled “Guess”.

Results

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 thirty-six unstudied faces. Results for the selection of studied faces and conjunctions are shown in Table 7.

Insert Table 7 about here.

Studied faces. Correct selection of studied faces was higher in the relational encoding condition than in the item-specific encoding condition (22 faces versus 18 faces) [$F(1,28) = 6.90$, $p < .05$]. This effect for encoding task did not extend to hits minus false-alarms for studied faces. The number of encoding trials also affected the selection of studied faces. More studied faces were selected after three encoding trials than after just one encoding trial (23 versus 17) [$F(1,28) = 17.16$, $p < .0005$]. Hit minus false alarm scores for studied faces were also higher after three encoding trials condition than just one encoding trial (12 versus 4) [$F(1,28) = 8.65$, $p < 0.01$].

Follow-up analysis showed that the encoding task reliably affected the selection of studied faces in the one encoding trial condition [$F(1,14) = 5.64$, $p < .05$]. More studied faces were selected by subjects in the relational encoding condition than the item-specific encoding condition (20 versus 14). This effect did not extend to hits minus false-alarm scores for studied faces ($p > .19$).

Conjunctions. The encoding task reliably affected the correct rejection of conjunctions as well as the incorrect selection of conjunctions. The item-specific encoding task supported greater rejection of conjunctions than the relational encoding task (6.7 versus 4.9) [$F(1,28) = 6.52$, $p < .05$]. 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) [$F(1,28) = 5.11$, $p < .05$]. There was no discernable pattern in the selection of conjunction faces based upon guessing.

Follow-up analysis showed an effect for encoding task on the rejection of conjunction faces in the three encoding trials condition [$F(1,14) = 5.83$, $p < .05$]. The item-specific encoding task led to the correct rejection of more conjunctions than the relational encoding task (6.6 versus 3.8).

The ability of subjects in the item-specific encoding condition to reject conjunctions did not vary significantly when 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) [$T(14) = 2.2$; $p < .05$].

Correct Guessing. More correct guesses were made in the item-specific encoding condition than in the relational encoding condition (2.1 versus 0.7) [$F(1,28) = 6.58$, $p < .05$]. This effect is attributed to the one encoding trial condition where item-specific encoding produced an advantage over relational encoding (3.0 versus 0.9) [$F(1,14) = 4.61$, $p < .05$]. No significant difference in correct guessing based upon encoding condition was seen after three encoding trials. Analysis of Hit minus False-Alarm rates for guesses showed that studied items were not distinguished from non-studied items by guessing.

Conclusion

At lower levels of learning the ability to rejection conjunctions was similar regardless of encoding condition. However, with three encoding trials, the item-specific encoding task provided a distinct advantage over the relational encoding task with respect to the ability to reject conjunctions. With repeated encoding trials, the ability to reject conjunctions was reduced in the relational encoding condition but remained above 60% in the item-specific encoding condition.

Overall Discussion and Conclusion

The model of face recognition used in this study relies largely on encoding task and face distinctiveness. As shown in Table 5, this approach provides an explanation for three quarters of more of the variance observed with one encoding trial, three encoding trials, and in the combination of all encoding trials. This ability to account for a large amount of the variance in both the one encoding trial condition and the three encoding trials condition provides a strong challenge to single process approaches. Nevertheless, if a single process approach is desired, then the values reported for remember and know judgments could be used to develop different weights for remember and know judgments with different levels of learning. The compensated values could then be used to produce a signal detection account for the two different methods of accessing the personal past represented in remember and know judgments. Such an approach would acknowledge the non-ergodic aspect of recognition memory while providing the cutting-edge precision of a binary distinction between one arbitrary level of memory and another.

Variation in the level of learning produced interesting variations in the production of remember and know judgments with both encoding tasks. With the item-specific encoding task and low levels of learning, more remember judgments than know judgments were observed. At low levels of learning, the item-specific encoding task was linked to within-item relational processing of complex stimuli. The various elements of a face, the eyes, the chin, the hairline and so forth are bound together by within-item relational processing. The link between within-item relational processing and an item-specific encoding task at low levels of learning was presented as an explanation of the predominance of remember judgments observed with just one encoding trial. The expectation for a reversal of this relationship, so that the item-specific encoding task produces a preponderance of know judgments with multiple encoding trials, was based upon an observed commonality between two different lines of research with respect to the retention of memory. Gardiner & Java (1991) found that memory associated with know judgments did not decline as rapidly as memory based upon remembering. This link between know judgments and retained memory was echoed in the research of Hunt and colleagues. In a line of research that focused on verbal stimuli, item-specific processing was assumed to promote distinctiveness in memory and distinctive items were assumed to be retained longer than less distinctive items. This tenuous link between item-specific processing and the production of know judgments was supported at higher levels of learning in experiment one, where a predominance of know judgments were produced.

Low levels of learning with the relational encoding task produced a predominance of know judgments. This observation is partially explained by the need to distinguish one face from another in order to assign the face to one and only one category. The ability to distinguish one face from another is obtained by item-specific processing. So, the initial stage of any between-item relational encoding task involves item-specific processing. When the stimuli are complex, as faces are, then the initial item-specific processing can be significant and a predominance of know judgments is likely to ensue. At higher levels of learning the focus of the category sorting task shifts from developing an ability to distinguish one face from the next to finding commonalities between faces. The search for commonality between faces is dominated by relational processing and produces a preponderance of remember judgments.

Based upon the results of experiment one, there is no clear-cut advantage to either encoding task with respect to overall recognition. However, the item-specific encoding task should provide an advantage over the relational processing encoding task with sufficient learning. In order to investigate this advantage a second experiment was carried out. In experiment two, the four encoding conditions of experiment one were again pressed into service with a single homogeneous study list. The recognition test for experiment two was simplified with the intention of determining the ability of subjects to reject conjunction faces.

With three encoding trials there was a clear advantage for the item-specific encoding condition over the relational encoding condition with respect to the ability to reject conjunctions. Interestingly, this advantage was not observed with one encoding trial and only appeared with repeated encoding trials. This result is consistent with the expectation that category sorting focuses attention on similarities between faces and not on the attributes of individual faces. Experiment two demonstrates an advantage that is obtained with item-specific processing over relational processing when the goal is the identification of an imposter.

An important distinction between relational processing/item-specific processing as primitive processes of cognition and encoding tasks intended to emphasize one primitive process over the other is illustrated in the current study. At low levels of learning, an encoding task that is intended to preferentially engage one primitive process over the other may not accomplish the intended goal. Encoding tasks are not process pure and characteristics of the stimuli, such as complexity or distinctiveness, should be factored in when considering which primitive process is likely to be engaged.

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Table 1

Hit Rates (HR), False Alarm Rates (FAR) and Hit minus False Alarm Rates (H-FA) by Number of Encoding Trials, Encoding Task, and Study List. Standard errors of the means are shown in parentheses.

	Homogeneous			Heterogeneous		
	HR	FAR	H-FA	HR	FAR	H-FA
Number of Encoding Trials						
1						
Distinctiveness Rating	.80(.03)	.29(.04)	.51(.03)	.78(.03)	.28(.03)	.50(.04)
Category Sorting	.82(.03)	.32(.04)	.51(.04)	.73(.03)	.38(.04)	.35(.03)
3						
Distinctiveness Rating	.88(.03)	.24(.04)	.65(.04)	.85(.02)	.29(.04)	.56(.03)
Category Sorting	.92(.02)	.11(.02)	.81(.03)	.82(.02)	.26(.02)	.56(.03)

Table 2

Analysis of Variance for Overall Recognition (H-FA), Correct Remember Judgments, Remember H-FA Scores, Correct Know Judgments and Know H-FA Scores. Standard errors of the means are shown in parentheses.

		Overall Recognition	Remember		Know	
Source	df	H-FA	Correct	H-FA	Correct	H-FA
Encoding Task (A)	1	n.s.	9.17 *	10.35 **	8.75 **	14.29 ***
Encoding Trials (B)	1	38.29 ****	n.s.	7.63 **	n.s.	8.32 **
A x B	1	7.47 **	44.47 ***	45.54 ****	51.63 ****	35.93 ****
Error term	60	(.027)	(.042)	(.038)	(.035)	(.035)
Study List (C)	1	35.67 ****	n.s.	8.97 **	n.s.	5.09 *
A x C	1	15.07 ***	n.s.	n.s.	n.s.	n.s.
B x C	1	4.55 *	n.s.	n.s.	n.s.	4.03 *
A x B x C	1	n.s.	n.s.	n.s.	n.s.	n.s.
Error term	60	(.013)		(.013)		(.014)

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$.

Table 3

Time, In Minutes, Expended Encoding a Study List by Number of Encoding Trials and Study List. Standard errors of the means are shown in parenthesis.

	Homogeneous List	Heterogeneous List
1 Encoding Trial	4.2 (.40)	3.6 (.23)
3 Encoding Trials	9.9 (.60)	7.9 (.48)

Table 4

Analysis of Variance for Overall Recognition (H-FA), Correct Remember Judgments, Remember H-FA scores, Correct Know Judgments and Know H-FA Scores. Standard errors of the means are shown in parentheses.

	Overall		Remember		Know	
Source	df	H-FA	Correct	H-FA	Correct	H-FA
Encoding Task (A)	1	n.s.	9.17 **	10.35 **	8.75 **	14.29 ***
Encoding Trials (B)	1	38.29 ***	n.s.	7.63 **	n.s.	8.32 **
A x B	1	7.47 *	44.47****	45.54 ****	51.63 ****	35.93 ****
Error term	60	(.013)	(.021)	(.019)	(.017)	(.017)
Distinctiveness (C)	1	5.79	49.11 ****	34.13	9.88 **	n.s.
A x C	1	n.s.	n.s.	n.s.	n.s.	n.s.
B x C	1	n.s.	n.s.	n.s.	n.s.	n.s.
A x B x C	1	n.s.	n.s.	n.s.	n.s	n.s.
Error term	60	(.016)	(.007)	(.008)	(.006)	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$.

Table 5

R^2 Values For A Model of 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.

	Overall Recognition	Remember		Know	
Source	H-FA	Correct	H-FA	Correct	H-FA
All Conditions	.59	.85	.79	.81	.76
1 Encoding Trial	n.s.	.84	.78	.79	.98
3 Encoding Trials	n.s.	.85	.78	.82	.79

Table 6

Comparison of Hit minus False Alarm Scores (H-FA) and A´ Values for Remember (R) Judgments and Remember plus Know (R + K) Judgments. Standard errors of the means are shown in parentheses.

Study List and Encoding Task	H-FA			A´		
	R	R + K	difference	R	R + K	difference
Number of Encoding Trials						
Distinctiveness Rating						
1	.37(.03)	.50(.03)	.13 ****	.80(.01)	.83(.01)	.03 **
3	.23(.03)	.65(.03)	.42 ****	.73(.03)	.89(.01)	.16 ****
3 – 1	-.14 ****	.16 ****		-.07 **	.06 ****	
Category Sorting						
1	.25(.03)	.45(.02)	.20 ****	.74(.03)	.81(.01)	.07 **
3	.57(.03)	.67(.03)	.10 ****	.88(.01)	.90(.01)	.02 **
3 – 1	.33 ****	.22 ****		.14 ****	.09 ****	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$ by *t* test.

Table 7

Experiment 2. Contrast of Encoding Tasks At Two Levels of Learning. Standard errors of the means are shown in parenthesis.

	Studied Faces	Studied minus Unstudied Faces	Conjunctions Accepted	Conjunctions Rejected
1 Encoding Trial				
Distinctiveness Rating	14.1(2.1)	1.1(2.6)	2.5(0.6)	6.8(0.6)
Category Sorting	19.8(1.0)	5.9(2.3)	3.3(0.5)	6.0(0.5)
3 Encoding Trials				
Distinctiveness Rating	21.9(1.3)	13.5(3.2)	2.6(0.8)	6.6(0.8)
Category Sorting	23.6(0.8)	10.0(3.0)	5.3(1.0)	3.8(0.9)

Figure Captions

Figure 1. Proportions of correct Remember (R), Know (K), and Guess (G) responses by encoding task and number of encoding trials. The distinctiveness rating task is represented in white the bars. The category sorting task is represented in the shaded bars. Vertical bars indicate standard errors of the means.