The Role of Familiarity and Associative Competition in Building Novel Structures

Michaela Katherine Spehn
Department of Psychology; Carnegie Mellon University
Pittsburgh, PA 15213 USA

Lynne Reder
Department of Psychology; Carnegie Mellon University
Pittsburgh, PA 15213 USA

ABSTRACT

Whose name will the teacher remember: Paul Einstein, Eric Baker, or Lisa Kounkel? What distinguishes these three last names are the familiarity a normal observer has with the name, and the associative competition of first names for that name. These experiments examined whether subjects could more easily learn new name combinations involving rare (Kounkel), famous (Einstein) or common (Baker) last names. Famous names supported the best pair learning with common first names. Einstein and Baker both have strong memory representations, but Baker has many name associations, making it difficult to access a new association, due to less activation reaching the new associative structure. We hypothesize that Kounkel lacks sufficient strength to support novel structures, so that it will be more difficult to distinguish the original first name with which it appeared.

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What affects memory for associations? How and when are these higher-level structures formed? These are the general questions inspiring the following experiments. Many of the details have been worked out. We know that practice and elaboration on an arbitrary association makes the memory for it stronger. When one of the associates is not well-learned — does not have a well-formed representation in memory we would also expect that associations involving it would be more difficult to form. When one of the components has a high number of associations already, it should be more difficult for any given association to be recalled. These last two factors make the components less ideal, and make learning more difficult. We will be examining how these factors affect learning in the context of names. Proper names make up a natural set of stimuli with various levels of familiarity and associative competition. Most importantly/uniquely, famous names naturally have high familiarity and low fan, a combination that is not to be found in words.

When learning someone's name — first and last — for the first time, the creation of a representation for the full name can be hindered by several factors. First, the name may never have been seen before, so a representation for that name would have to be developed, before it can be linked to the other name. This happens not infrequently for last names and occasionally for first names as well. For example, when one meets Lisa Kounkel, one must first learn *Kounkel* as a unified chunk, and not continue to represent the name as the combination of syllables. As a name is seen for the first time, an episode node encoding this event is created with links to the pieces of the last name — either phonemes or syllables — and a link to the context node (a node representing the contextual details of the event). Through repeated presentation, the episode becomes stronger and the contextual fan increases. It then becomes a non-contextualized representation of the name itself. See Figure 1. Can a link be made from this representation immediately after its creation? Or, must the representation be strengthened through prolonged or repeated exposure for it to acquire the necessary strength to support such a structure? Second, if the name is fairly common, associations with that name will have competition with all the other names with which it has been linked in memory. So when one tries to learn a colleague's name — Eric Baker, one has competition on *Baker* from Grandmother Mabel Baker, Jeweler Larry Baker, and Childhood Friend Harry Baker. If the colleague is introduced again at a party as Mr. Baker, one may have difficulty in retrieving *Eric*. This competition can occur in both first and last names. As *Eric* is also a common name, one will likely have trouble in retrieving *Baker*, if he is introduced by his first name.

In the four experiments which will be presented here both of the factors described above — familiarity and associative competition — are studied. The experiments use names as materials, but the underlying mechanisms are assumed to be general to the learning of complex combinations of components — both known and unknown. Names are especially useful in this context because familiarity and associative competition are not always linked.

There is a large body of research that has been done on the recognition of low frequency and high frequency works. Most interesting has been the mirror effect, wherein the high frequency words receive more false alarms and fewer hits than low frequency words. We expect that the response to high frequency and low frequency last names in isolation will show a similar pattern. (Reder, et al 2000) The Source of Activation Confusion account of these findings points to familiarity-based decisions leading to false alarms, with the high frequency words being more prone to this. The low fan of the low frequency words increases the chances of a recollection by increasing the activation being sent to the episode node, and thereby decreasing the possibility of a familiarity-based judgement. These studies on words have been bound by the fact that high frequency words appear in many contexts and therefore must have high associative competition as well as high familiarity. Proper names do, however, provide a natural set of high frequency, low fan stimuli — famous last names. These names are rare in the general population, but are connected to one or two first names denoting famous people who are discussed frequently in the popular culture. These should afford more recollections because of the lower fan, and therefore more hits than common last names.

The effects of associative competition in the retrieval of learned facts have been studied for years within the literature on semantic networking. The experimental result that the more individual facts one knows about something the harder it is (the more time it takes) to access any particular associated fact is discussed in Anderson (1974) and Reder & Ross (1983). Using again the examples above, this is like not remembering Mr. Baker's first name. Semantic network models provide a compelling theoretical mechanism to explain this result. A node's activation, which it receives on presentation of the item the node represents, is distributed among the connections that node has to other nodes. The more connections, the less activation reaches any one associated node. This node may then lack sufficient strength to make the memory conscious, bringing the represented item to mind. The other nodes may also acquire high enough activation to become conscious and cause interference. Fitting with the pictorial representation, this is commonly called the fan effect.

The effects of component strength on the strength of the node created to represent a higher level structure are central to such semantic network models. Current models believe that a trace is made at the first presentation, even when the components are themselves new. Thus, although one has difficulty learning *Lisa Kounkel*, there is a link connecting the *Lisa* node and the weak *Kounkel* episode node immediately. We propose that this is not the case, that instead one must have a stable representation of *Kounkel* before the instance in which it is associated with *Lisa* can be represented. We will call such a node with sufficient strength for a higher level structure to be made with it as a component a chunk. This terminology is meant to be evocative of the chunking of information which is found to be important in learning about a domain.

We embarked on this study with the double goal of reaffirming the influence of greater fan on the recollection of the study event node attached to each associate and of determining if such a study event node is actually established before its sub-components are chunks. We predicted that it would be easier to remember pairings involving the famous names than pairings involving the common names, because of the lower fan of the famous names and their comparable base-level activation. We predicted that it would be easier to remember pairings involving the famous names than pairings involving the rare names, because the rare names would not be chunks, and there would seldom be a node formed connecting the rare last name to the first name.

EXPERIMENT 1

METHOD

Subjects

Twenty-one Carnegie Mellon University undergraduates participated in this experiment in partial fulfillment of a course requirement.

Design and Materials

This experiment involved a nested 3 (type of last name: common, famous, rare) X 3 (test combination: original, swapped, new) within subject design. Although type of last name is a quasi-experimental variable, assignment of names to test conditions was random for each subject.

The last names used in the experiment are of three types. Both the common and rare last names were chosen off of a frequency list based on 1990 US Census Data of the most frequent names in the population. The common last names were the 80 most common last names (frequency range: 1 to 10/1000 people). The rare last names were 80 names with a frequency less than 1/100,000. They were chosen randomly from the end of the list to supply a range of initial letters. Famous last names were names not registering on the Census Data, and therefore having an estimated frequency of less than 1/1,000,000. These names were the least frequent in the population of all names used in the study. A pool of names was generated by an undergraduate student by availability and through reading magazines. The eighty names were confirmed as famous by being recognized by at least 95% of twenty undergraduates surveyed.

The first names used were all chosen from 1990 US Census Data lists of the most frequent names by gender. The male first names chosen were the 45 most frequent names (frequency range: 3 to 33/1000 men). The female first names chosen were the 45 most frequent names (frequency range: 3 to 26/1000 women).

The study list Subjects saw consisted of 20 common last names, 20 famous last names, and 20 rare last names. For each of the three name types, there were ten female and ten male common first names randomly paired to the last names. Each resulting study list of 60 names was randomized.

The subsequent recognition list includes thirty name pairings off of the presentation list. The other 30 name pairings had first names swapped with each other within type and within gender, so that if "Alice Smith", "Janet Price", and "Barbara Parker" were names on the presentation list, "Alice Price", "Janet Parker", and "Barbara Smith" could be on the recognition list instead. The final 30 names were new pairings, created in the same way as the names appearing on the presentation list. The last names used for these new pairings were names not used in the presentation list. The first names used for the new pairings were ones that had already appeared on the presentation list with other last names, and would again appear on the recognition list with other last names. Thus, the final recognition list consisted of names in three types— common, famous and rare — and three conditions — original, swapped, and new.

Lists were randomly determined for each Subject. (It was the presumption that this randomization would even out any accidentally famous pairings.)

<u>Procedure</u>

The Subjects were seated in front of a computer and told to study each name pair presented on the screen for a later test. Each name pair stayed on the screen until the Subject pressed a key to indicate that they were ready for the next pair.

When the Subject completed study of the 60 pairs, the test phase of the experiment began. Subjects were told to judge a name pair as "original" [1]if it was a pair that appeared on the presentation list, "swapped" if first name and last name appeared on the presentation list, but in different pairs, or "new" if the name did not appear on the presentation list.

The recognition list was presented in a manner similar to the study list, with a pairing appearing on the screen until the Subject indicated his or her choice of "original", "swapped" or "new" through a key press. Each Subject completed the procedure twice.

The dependent variables measured were recognition accuracy and response time. The time spent studying the pairing at presentation was also recorded.

[1] The subject was actually presented with the choice of "old" rather than "original". The terminology has been changed in the paper to maintain consistency with Experiments 2-4.

RESULTS AND DISCUSSION

In the analyses performed across all four experiments, we adopted a significance level of $p<.01$ and report the p value only in the cases when the statistic is less reliable.

An Anova test using test block as a factor showed no significant difference, nor any interactions, for all name types in percent correct, $F<1$. Given that the descriptive statistics were also very similar across blocks, all further discussions will ignore block as a factor.

The percentages of correct responses for each name type and condition combination in the experiment are given in Table 1. A repeated measures Anova was done with last name type and condition as factors. There were significant differences within condition, with new names being easier to identify than original names and original names easier than swapped names, $F(2,40)= 15.22$, MSE =0.27. There were also significant differences within last name type, with famous name pairs easier to identify than common name pairs and common name pairs easier than rare name pairs, $F(2,40)=9.34$, MSE=0.85. However, the analysis also showed that for last name type across conditions there was a strong and significant interaction, $F(4,80)=14.85$, MSE=0.21. See Figure A. Pair comparisons were then made within each pairing condition.

Identifying new names was significantly harder for common last names 57% than for either rare 76% or famous last names 74%. ($F(1,20)=18.41$, MSE=0.40; $F(1,20)=10.36$, MSE=0.29) Our interpretation is that the base activation of common names is high, but the source of the activation is difficult to identify, because the high fan gives low activation to the episode node. The subject can therefore think that the name was seen in the experimental context when it was not.

Identifying swapped names was significantly harder for rare last names 39% than for either famous 49% or common last names 49%, respectively, $F(1,20)=7.62$, MSE=0.11, $p<0.02$; $F(1,20)=9.15$, MSE=0.10. Our interpretation is that it is more difficult to create a new trace or node that links first and last name, when one of the constituents (in this case, the last name) is not strong enough to be a chunk. Identifying original names was harder for rare last names than it was for common last names, which was in turn harder than it was for famous last names, $F(1,20)=10.00$, MSE=0.10; $F(1,20)=20.09$, MSE=0.30)

Although it is not formally appropriate to use SDT with a three-alternative forced choice procedure, we found it desirable to analyze our data in terms of hits and false alarms and calculate the d-prime. Given that both original and swapped pairs use old last names and both responses indicated that the subject thinks that the last names are old, we decided to calculate d'. We treated original and swapped responses and "old", and treated all old last name pairs the same (whether original or swapped), and computed d'.

Table 2 shows the results of a signal detection analysis performed in this way. The false alarm rate corresponds to the rate at which the subjects responded with either "original" or "swapped" to pairings that were actually new. The results show that the common pairs had a much higher false alarm rate 43% than either the famous or rare pairs (23% and 20% respectively), $F(1,20)=18.41$, MSE=0.40; $F(1,20)=10.36$, MSE=0.29. This high false alarm rate can be attributed to the high degree of associative competition off of these common last names, to the high base-level activation of common last names, or to a combination of both of these factors. The fan off of the common name would mean that the activation the name node receives when the subject views the name is distributed out to all associated nodes, not only the one representing the encoding event that occurred some ten minutes previous. This can mean that the relevant episode node may often not receive sufficient activation to push it over threshold. The subject is left with no good way to discriminate name pairs, and makes a large percentage of false alarms. If subjects resort to deciding which last names are new or old based on the familiarity of the name rather that the retrieval of an event node, then the high base-level activation of the common last names could result in more "original" or "swapped" responses when the name is actually new.

The hit rate corresponds to the rate at which the subjects responded "original" or "swapped" when the pairings were either original or swapped. The results show that the famous pairs had the highest hit rate. Common pairs have a hit rate of 77% and rare pairs have a hit rate of 66% . The data suggest that the familiarity with the name has a greater relation with hit rate than the associative competition. Both common and famous names are familiar to the subject, and the nodes representing these names are likely to be strong. Such strong nodes make good foundations for full name structures learned in the experimental task. The rare names are unfamiliar to the subject, who will likely be forming a representation of them for the first time. We believe that the short study period the subjects used (~ 1000-5000ms) allows for only a weak episode node to be formed as a representation of the rare last names. Such a node would node support the creation of the higher-level representation of the full name.

The d-primes associated with this analysis are more suspect, as the statistics are geared to a two-choice situation. Nevertheless, we may accept the ranking of famous pairs as the most easily discriminated (d’ = 2.43), rare pairs next (d’ = 1.74) and common pairs as the least easily discriminated (d’ = .96).

No such application of signal detection theory is possible for the distinction between original and swapped pairings.

In order to further test our interpretation that performance on common names was hurt by too many associations while that on rare names was hurt because of insufficient strength to promote a trace that associates the first and last name, we decided to vary the familiarity of the first name. If our interpretations are correct, then the subjects should show much better performance on common last names paired with unusual (low-fan) first names than with those paired with common (high-fan) first names. The variation of the first name fan plays a role in the retrieval, rather than the encoding, of the association. This is because both common and unusual first names have representations with high base-level activation, which should support higher level structures. It should therefore affect distinguishability only in the cases where a higher-level structure was actually formed, which would be much less likely for rare last name pairings.

In addition, Experiment 2 was designed with a tiered choice structure so as to make the application of Signal Detection Theory and the interpretation of base rates more appropriate. We anticipated that this series of binary decisions would lead to some other interesting response patterns. Namely, there would be a possibility of the subject correcting a wrong answer when given a second chance with the added information of the first name. We predicted that this would be more likely with the unusual first names and common last name pairings, because these first names send more activation to the episode node than the last names do. If the episode was encoded, this extra activation could bring the node past threshold and the subject will recollect the correct answer whereas before he may have been forced to rely on a familiarity judgment.

EXPERIMENT 2

METHOD

Subjects

Twenty-five Carnegie Mellon University undergraduates participated in this experiment in partial fulfillment of a course requirement. The data from five Subjects were excluded due to: an excess of changes between the first and second decision showing that they were not performing the task correctly (4); and, too few correct responses to the first decision, yielding misleading percentages in the second decision (2).

Materials

The names used in Experiment 2 were the same as those used in Experiment 1 with a few exceptions.

Additional sets of unusual male first names and unusual female first names were chosen from the 1990 US Census Data lists. The male unusual first names were 60 names from ranging in frequency from 37 to 69 /100,000 males. The female unusual first names were 60 names ranging in frequency from 40 to 68/100,000 females. The names were chosen to avoid common English words (eg. *Daisy*), similarity with another name on the list (eg. *Karl* excluded because of *Carl*), or being a nickname of a more common name (eg. Bobbie).

The sets of names from Experiment 1 were also altered by removing names that were extremely similar, common English words, or extremely long. The new set of male common first names consisted of 60 of the most frequent 64 names (frequency range: 2.7 to 33/1000 within sex). The new set of female common first names consisted of 60 of the most frequent 64 names (frequency range: 3.0 to 26/1000 within sex). The common last names remained unchanged. The new set of rare last names consisted again of 80 names with a frequency less than 1/100,000. The Famous last names again had an estimated frequency of <1/1,000,000.

Design and Procedure

The subjects completed a recognition task. The first list they saw was a presentation list of 72 names. This list was made up of six types of name pairings according to the two by three design, in which three levels of last names: common, famous and rare, were paired with two levels of first names: common, and unusual. To construct this list, 18 common male first names, 18 unusual male first names, 18 common female first names, 18 unusual female first names, 24 common last names, 24 famous last names, and 24 rare last names were selected randomly. These names were paired randomly so that there were an equal number of male and female names in each of the three types. The lists were then screened for any famous name pairings obvious to the experimenter (ex: John Travolta). If such a name appeared, the list was destroyed and a replacement list compiled. This occurred twice. The order of each list was subsequently randomized.

The second list the subjects saw was a recognition list of 108 names. Thirty-six name pairings off of the presentation list were repeated on this list. The other 36 name pairings had first names swapped with each other within type and within gender, as in Experiment 1. The final 36 names were new pairings, created in the same way as the names appearing on the presentation list. Both the first and last names used for these new pairings were names not used in the presentation list. Thus, the final recognition list was made up of names in six types— common-common, unusual-common, common-famous, unusual-famous, common-rare and unusual-rare — and three conditions — original, swapped, and new.

Each subject received a unique list.

The procedure is similar to that of Experiment 1. When viewing pairs off of the presentation list, the pairs appeared for only 2.5 s. with an inter-stimulus interval of 1 s. Subjects were instructed to read the name out loud and try to remember the pairing of first and last name. When the Subject completed study of the 72 pairs, instruction was given on what made a pairing "original" (pairing that appeared on the presentation list), "swapped" (first name and last name that appeared on the presentation list, but in a new pairing) or "new" (first name and last name that did not appear on the presentation list). There were two tests for each trial in this experiment. In the recognition phase, the subject was first shown the last name only and told to judge whether the name was old or new. Regardless of choice, the Subject was presented with the first name as well, and was told to judge whether the pair was original, swapped or new. The Subject was instructed that it was possible to change one's mind after seeing the first name, but this should be avoided by concentrating on the preliminary judgment on the last name only.

The subject repeated the entire procedure a second time, with non-intersecting lists of names.

The dependent variables measured were recognition accuracy and response time.

RESULTS AND DISCUSSION

The scores from both runs were combined to increase the number of trials in each condition. A test done to determine if the two blocks were significantly different for each last name type in overall percent correct showed such differences for neither the judgment on last names: ($F(6,13)=0.051$, $MSE=0.014$) nor the judgment on name pairs: ($F(6,13)=0.108$, $MSE=0.036$). This was especially necessary, as there were a greater number of types in Experiment 2 than in Experiment 1.

All response rates were analyzed according to Signal Detection Theory.

Preliminary Judgment on Last Name Only

The first decision that the subjects made, whether the pairing was old or new, corresponds roughly to the analysis done in Experiment 1. The types were pooled according to last name type, as the decision was made while the subject only saw the last name. There is no main effect of first name type seen during encoding on recognition of last names, as there were no significant differences between the common and unusual conditions for this decision (New: $F(2,95)=0.06$, $MSE=0.00$; Swapped: $F(2,95)=0.108$, $MSE=0.05$; and, Original: $F(2,95)=0.91$, $MSE=0.05$). The percent correct responses for the initial judgment on last name alone are shown in Table 3. The results show a similar pattern as in Experiment 1, although numbers for original and swapped names are combined, as no first name is as yet visible to the subject. Identifying new names is hardest for common last names. Identifying old names is easiest for famous last names. A signal detection analysis for the initial decision is given in Table 4. It is clear that the false alarm rate for the common last name pairs ($M=0.36$) is still about twice that for the famous or rare last name pairs (M= 0.17 and M= 0.17 respectively). (F(2,38)=13.25, MSE=0.23) The hit rate for the famous last name pairs is still highest (M=0.90), but the hit rates for common and rare last name pairs were about the same (M=0.72 and M=0.72 respectively). (F(2,38)=19.12, MSE=0.23) The d-primes for each of the three conditions are much more reliable because of the binary choice. Famous pairs still seem to be the most easily identified (d' = 2.63), rare pairs are still next (d' = 1.75), and common pairs are still the hardest to identify (d' = 1.18). This generally replicates Experiment 1; the only difference being that the hit rates for common pairs and rare pairs seem to be the same. This may show that associative competition has some effect on hit rate as well as false alarm rate, as this would be one of the major differences between common and famous last names.

Secondary Judgment on First and Last Name

The second decision the subjects made, whether the pairing was original or swapped, was new to Experiment 2. The percent correct responses given in the second decision are shown in Table 5. Of note is how poorly subjects were able to identify the swapped pairs.

Responses included for the signal detection analysis were only those for which the first choice had been old and the second choice was either original or swapped.

Table 6 shows the results of the signal detection analysis performed on the remaining trials in each condition. The false alarm rates for each of the six conditions is the roughly the same, ranging from M=0.48 to M=0.51 save for an anomalous M=0.59 for the common-famous pairs. The difference between false alarm rates for common-famous and unusual-famous pairs is not significant (F (1,19) = 3.69, MSE = 0.07). The hit rate for famous last name pairs at M= 0.82 is not significantly higher than the hit rate for common last name pairs at M=0.79 (F(1,19) = 1.35, MSE = 0.01). The rare last name pairs (M=0.69) do have significantly lower hit rates than either common (M=0.79) (F(1,19) = 5.50, MSE = 0.09, $p < 0.05$) or famous (M=0.82) (F(1,19) = 15.88, MSE = 0.17) last names, with unusual-rare pairs (M=0.66) slightly but insignificantly worse than common-rare pairs (M=0.69). (Double check numbers)

The discriminability for the common-rare (d' = .62) and unusual-rare (d' = .64) pairs are both significantly less than the d-primes for all the other conditions. There are no significant differences between the common first name and unusual first name condition for any last name type, but we can see the trends. Subjects performed better on unusual-common pairs (d' = 1.29) than on common-common pairs (d' = .92); they performed better on unusual-famous pairs (d' = 1.22) than on common-famous pairs (d' = .98); but, they performed only very slightly better on unusual-rare pairs than on common-rare pairs. These differences are shown in Figure 2.

Experiment 3 is a repetition of Experiment 2, in which the new last names are paired with old first names rather than new first names. We felt that the new first names made it too easy to recognize the new pairings, and caused too many changes of mind between the first and second decisions.

Experiment 3

METHOD

Subjects

Thirty Carnegie Mellon University undergraduates participated in this experiment in partial fulfillment of a course requirement.

Materials

The names used in Experiment 3 were the same as those used in Experiment 2.

Design and Procedure

The lists were compiled for Experiment 3 in the same manner as they were for Experiment 2, with one exception. The final 36 new name pairings on the recognition list were created by combining last names that were not on the presentation list with first names that were on the presentation list.

Each subject received a unique list.

The procedure is similar to that of Experiment 2.

The Subject repeated the entire procedure a second time, with non-intersecting lists of names.

The dependent variables measured were recognition accuracy and response time.

RESULTS AND DISCUSSION

An Anova test using test block as a factor showed no significant difference, nor any interactions, for all name types in percent correct, F<1. Given that the descriptive statistics were also very similar across blocks, all further discussions will ignore block as a factor.

All response rates were analyzed both by percent correct identification of the condition (as new, swapped or original) and according to Signal Detection Theory.

Preliminary Judgment on Last Name Only

The results of the analysis of the response pattern to the first decision the subjects made echoes those of Experiment 2. The percent correct responses for this judgment on last name alone are shown in Table 5. Identifying new names is still hardest for common last names, just as identifying old names is easiest for famous last names. A signal detection analysis for the initial decision is given in Table 8. The Subjects seem to have an even worse false alarm rate for the common last name pairs (M=0.45), while the famous and rare last name pairs seem to be holding at the same level (M=0.16 and M=0.16 respectively). (F(2,58) = 50.26, MSE = 0.86) The most interesting departure from the results of Experiment 2 for this decision is the newly significant difference in hit rate for common (M=0.82) and rare (M=0.72) last name pairs. (F(1,29) = 13.61, MSE = 0.27) The d-primes show that the famous last name pairs are still the most easily distinguished (d’ = 3.06), followed by the rare last name pairs (d’ = 2.30) and the common last name pairs (d’= 1.27). This replicates a general pattern in results found in Experiments 1 and 2. As the real difference between Experiments 2 and 3 lies in the type of first names paired with the new last names in the recognition list, we did not expect any marked differences in subject performance on the preliminary decision on last name only.

Secondary Judgment on First and Last Name

Subject performance on the second decision in this experiment was very different from that in Experiment 2.

Table 9 shows the percent correct responses given in the second decision. First name unusualness seemed to make less of a difference for identification of new last names. As these numbers are from the subjects' final identifications of the name pair, it suggests that in Experiment 2 the subjects were relying on the first name to make the difficult decision of whether a common last name has been seen before or not. The first name unusualness seemed to not help the subjects very much in distinguishing between swapped and original pairs.

Just as in Experiment 2, responses included for the signal detection analysis were only those for which the first choice had been old and the second choice was either original or swapped.

Table 10 shows the results of the signal detection analysis performed on the remaining trials in each condition. The false alarm rates for the common last name pairs (M=0.38) appear lower than the false alarm rates for either the famous or rare pairs (M=0.45 to M=0.46). This difference on the last name is significant ($F(1,29) = 5.19$, $MSE = 0.08$, $p < .05$). The hit rates for the rare last name pairs (M=0.62) are also significantly lower than the hit rates for the common and famous last name pairs (M=0.73 to M=0.76) ($F(1,29) = 22.03$, $MSE = 0.23$). First name type is related to no significant differences within last name for false alarm and hit rates.

Curiously, these marginal results for false alarm and hit rates add up to some surprising patterns in d-primes. The non-significant but sizable first name effect for common last names found in

Experiment 2 is gone: unusual-common d′ = 1.29, common-common d′ = 1.28. A first name effect appeared for rare last name pairs where there was none in Experiment 2: unusual-rare d′ = .84, common-rare d′ = .44. Subjects again performed better on unusual-famous pairs (d′=1.13) than on common-famous pairs (d′= .86). These differences are shown in Figure 3.

These results cause problems for our interpretations of the previous experiments. Most importantly, we had expected that the unusual first name would be most helpful in distinguishing original from swapped pairs for common last name pairs. The famous last names were thought to send enough activation to the episode node that any activation coming from the first name node would be enough to bring the episode node over threshold and the event into consciousness. Experiment 2 seemed to support this, although the differences were not significant. Experiment 3 now gives us significance for famous last name pairs ($F(1,29)= 10.23$, $MSE= 11.18$, $p < .005$) and shows no difference for common last name pairs.

The fact that there are no significant differences on first name in false alarm and hit rates raises suspicions about the d-primes. Small differences may be adding up to misleading results. There were several problems with this experiment that may have contributed to these results. The use of old first names with new first names as well as old last names likely made the task much harder. Subjects no longer had the extra hint that the last name was new. Probably more important, the old first name ushered in an interference of the last name that originally appeared with it. Also, during the test phase, the subject will frequently see first name paired with yet another last name (in swapped conditions) prior to seeing it with a new name. The first name becomes an active distraction rather than a cue.

It is possible that whereas the new first names used in Experiment 2 made the task too easy, the old first names (which were seen on the same list both with old names and new names) used in Experiment 3 made the task too difficult. As the preliminary decision on last name alone seemed to provide consistent results for both Experiments 2 and 3, we decided to design an experiment focused on the secondary decision — the distinction between original and swapped name pairs.

In Experiment 4 we narrowed the focus to whether a new trace between nodes can only be made if the components are chunks. Of secondary interest was confirming the role of associative competition in the recollection of learned traces, as was suggested by the results of the previous three experiments. We simplified the design by removing the new pairings, and asking the subjects to distinguish only original pairings from swapped pairings. We expect that a reduction of competition, due to the unusualness of the first name linked to the last name, will increase the recollection for pairs for which associative competition is a problem — that is, for pairs with common last names. We expect that this manipulation will have no effect on pairs with rare last names, because event nodes connecting first and last names were seldom formed. There was insufficient time for the rare last names to become chunks for the subjects. We also expect that this manipulation will have no effect on pairs with famous last names. These have such low fan off of the famous last name node to afford enough activation to travel from them to the event node, that any activation from the first name node triggers its consciousness.

EXPERIMENT 4

METHOD

Subjects

Twenty-four Carnegie Mellon University undergraduates participated in this experiment in partial fulfillment of a course requirement. The data from five subjects were excluded due to: failure in a post-test assessing their recognition of famous last names as famous (4); and, choosing the same response for every trial in the second run of the experiment (1).

Design and Materials

This experiment involved a complete 2(type of first name: common, unusual) X 3 (type of last name: common, famous, rare) X 2 (test combination: original, swapped) within subject factorial design. Although type of last name is a quasi-experimental variable, we performed a random assignment of names to test conditions for each subject. Each subject completed the procedure twice. The names used were the same as those used in Experiments 2 and 3.

Procedure

The subjects completed a recognition task. The first list they saw was a presentation list of 72 names. This list consisted of six types of name pairings according to the two by three design, in which three levels of last names: common, famous and rare, were paired with two levels of first names: common, and unusual. To construct this list, 18 common male first names, 18 unusual male first names, 18 common female first names, 18 unusual female first names, 24 common last names, 24 famous last names, and 24 rare last names were selected randomly. These names were paired randomly so that there were an equal number of male and female names in each of the three types. The lists were then screened for any famous name pairings obvious to the experimenter (ex: John Travolta). If such a name appeared, the list was destroyed and a replacement list compiled. This occurred once. The order of each list was subsequently randomized.

The second list the subjects saw was a recognition list of 72 names. Thirty-six name pairings off of the presentation list were repeated on this list. The other 36 name pairings had first names swapped with each other within type and within gender, so that if “Alice Smith”, “Janet Price”, and “Barbara Parker” were names on the presentation list, “Alice Price”, “Janet Parker”, and Barbara Smith” could be on the recognition list instead. Thus, the final recognition list consisted of names in six types — common-common, unusual-common, common-famous, unusual-famous, common-rare and unusual-rare — and two conditions — original and swapped.

Each subject received a unique list.

The subjects were seated in front of a computer and told to study each name pair presented on the screen for a later test. When viewing pairs off of the presentation list, the pairs appeared for only 2.5 s. with an inter-stimulus interval of 1 s. Subjects were instructed to read the name out loud and try to remember the pairing of first and last name. When the subject completed study of the 72 pairs, instruction was given on what made a pairing “original” (pairing that appeared on the presentation list) or “swapped” (first name and last name that appeared on the presentation list, but in a new pairing). In the recognition phase, the subject was shown the first and last name with a prompt of “Swapped or Original?”. The pairing remained on the screen until the subject indicated his or her choice through push one of two labeled buttons on the button box. The subject repeated the entire procedure a second time, with non-intersecting lists of names.

RESULTS and DISCUSSION

The dependent variables measured were recognition accuracy and response time.

An Anova test using test block as a factor showed no significant difference, nor any interactions, for all name types in percent correct, $F<1$. Given that the descriptive statistics were also very similar across blocks, all further discussions will ignore block as a factor.

Table 11 shows the results of the signal detection analysis performed on each condition. The false alarm rates for the common last name pairs (34%) appear lower than the false alarm rates for either the famous or rare pairs (41% to 47%). These difference on the last name are significant, $F(1,18) = 10.18$, MSE = 0.14, and $F(1,18) = 7.51$, MSE = 0.11, $p< .05$. But this difference is driven by the unusual-common pairs, which have a significantly lower false alarm rate (27%), than the common-common pairs (40%), $F(1,18) = 11.23$, MSE = 0.19. This false alarm rate for unusual-common pairs is significantly different from that of all other name pair types, $F(1,18)=23.42$, MSE=.29. This low false alarm rate would correspond to the higher likelihood for enough activation to reach the episode node encoding the study events in swapped conditions. We would expect that unusual-common pairs would send more activation than common-common pairs to the event in which the first name originally appeared. However, this unusual first name benefit should appear for famous and last names as well. Additionally, the common-famous name pairs should send more activation to the events in which the famous last names originally appeared than the common-common last names, but there are actually more false alarms for the common-famous than for the common-common. This could be due to a bias to answer original to pairs involving famous last names, or there could be no such recollections possible of the studied pairing when only one of the associates is seen.

The hit rates for the rare last name pairs are also significantly lower than the hit rates for the common last name pairs, $F(1,18) = 6.83$, MSE = 0.06, $p < .05$, and famous last name pairs, $F(1,18) = 38.43$, MSE = 0.37. The common last name pairs also have significantly lower hit rates than the famous last name pairs, $F(1,18) = 15.28$, MSE = 0.13.

Table 12 shows the results of the signal detection analysis performed on the trials in each condition. The discriminability was better for unusual-rare pairs (d' = 0.30) than for common-rare pairs (d' = 0.68), but this result was not significant. Subjects performed significantly better on unusual-common pairs (d' = 1.28) than on common-common pairs (d' = 0.80), $F(1,18) = 5.18$, MSE = 2.19, $p < .05$, a reappearance of an effect that was found in Experiment 2, but not in Experiment 3. However, subjects also performed significantly better on common-famous pairs (d' = 1.35) than on unusual-famous pairs (d' = .85), $F(1,18) = 5.25$, MSE = 2.47, $p < .05$, a result which is opposite of the result in Experiment 3. See Figure 4 for graphical representation.

Experiment 4 was designed to answer three questions. Is the discriminability of original and swapped pairs increased for unusual-common pairs as opposed to common-common pairs? We have a statistically significant increase, but the increase seems rather small. Does the discriminability of original and swapped pairs show no increase for unusual-famous pairs as opposed to common-famous pairs? Here, we have the unexpected result that there is actually a decrease. This decrease is again be rather small, but it does have a statistical significance. Is there no increase in the discriminability of original and swapped pairs for unusual-rare over common-rare pairs? As this is testing a null hypothesis, there is no definitive answer. There is no significant difference, but the interval is large. Any increase does seem to be less than the increase for the common last name pairs.

General Discussion

The discrimination of old and new last names has given similar results throughout the three experiments in which it was measured. Famous names are reliably easier to discriminate than rare last names, which are again easier to discriminate than common last names. This pattern is driven by a greater number of false alarms for common last names, and a greater number of hits for famous last names. The SAC model of memory can explain this result elegantly by calling on the different base-level activations and fans of these different name types. Low fan names, like famous and rare names, send less activation to the episode node than high fan names, like common names. Since the higher activation of the episode node will trigger more recollection judgments of "original", there will be more hits. The rare last names have a lower base-level activation, which would cause less activation to reach the episode node — if an episode node is created containing this weak name node — and trigger fewer hits. The high base-level activation of the common last names, will result in the last name node being more likely to go over threshold and result in a false alarm. The high fan for these names will mean that less activation is sent by the common last name node than the famous last name node to the episode node. The resulting fewer non-recollections would result in a greater chance for false alarms to occur through familiarity judgments.

The results of the three experiments addressing the original versus swapped decision on name pairs do not lead to such harmonious conclusions. The only exception is that subjects are worse at discriminating original and swapped pairs for the rare last name pairs. The fair ability of subjects to discriminate old and new rare last names is juxtaposed with the terrible performance of subjects in discriminating original and swapped pairs when rare last names are involved. If we presume that there is only a small chance of the rare last name being represented with a strong enough node in memory for that node to become a chunk — for the node to accommodate the building of a higher level structure with it as a component — then there would only sometimes be an episode node to allow recollection judgments. For the original versus swapped decision, only recollection provide a good/veridical basis for judgment. There are also likely strategies that the subject can use in the first task, which are denied him in the second. For instance, the bizarreness effect has been shown in word recognition experiments showing an inhibition to respond "old" to a word that the subject has never seen before. (Citations) This empirically replicated result could be theoretically underpinned in SAC. The bizarreness that the subject may feel at the presentation of a rare name or extremely low frequency word, may reflect the absence of a node representing that name or word — neither an episode node nor a chunk. This bizarreness effect may only be relevant at the word or single name level and not at the phrase or full name level. Since both original and swapped pairs include old rare last names, this strategy is no longer useful.

The first name manipulation has produced less consistent results. We expected that the common last names would be helped by the unusualness of the last names and that the famous last names would not. Although Experiments 2 and 4 found significant increases in unusual-common pair discriminability over common-common pairs, these differences were not very large, and Experiment 3 found no difference at all. Experiments 3 and 4 show opposite effects for the unusualness of first names. Our explanation of the difference between common and unusual first names is that the associative competition off of the common first names is higher than that off of the unusual first names. If the unusual first names had been more unusual — less frequent in the population, while still having familiarity — it is possible that the effect would have been stronger.

The model predicts better performance with the unusualness of the first name precisely because the first name would provide more access to the episode node it was attached to, whether to provide a recollection of original or swapped. The increased recollections of swapped pairs would contribute to the unusual first name advantage. It is possible, that for an episode node to reach over threshold, an intersection of activation must occur. In other words, activation must be sent from both the first name node and the last name node. If this were the case, there would be no recollections of "swapped" and the unusual first name advantage would be minimal.

It is possible that there is an attentional shift toward the unusual first name that diminishes the strength of the new connection between first and last name. This could explain the worse performance on unusual-famous pairs than on common-famous pairs, an unexpected result form Experiment 4.

An initial meta-analysis was performed on the results of the secondary judgement from Experiments 2,3, and 4. Last name main effects of common better than rare and famous better than rare show strong effect sizes in all three experiments. When considering the number of subjects in each condition, the weighted average of both these effects are >0.80 SD, in the range of statistically large. The influence of the unusual first names was more varied across experiments. The benefit of the unusual first name for the common last names is seen in all three experiments, but each of these benefits has a medium effect size (>0.5) in only Experiment 4. The weighted average is 0.28 SD, which is usually classified as small. Any real benefit may not be practically significant. For famous last names, the effect size is strong in Experiment 4 for common first names being easier to identify, but is countered by two small effect sizes in the opposite direction found in Experiments 2 and 3. It is probably prudent to point out that each of the Experiments had a different procedure. As Experiment 4 was pared down to emphasize the secondary decision, we may want to put more weight on its results.

Tables

Table 1
Experiment 1: Percent Correct

	Common	Famous	Rare
new	.57	.74	.76
swapped	.49	.49	.39
original	.55	.71	.45

Significant comparisons
New: F>C, R>C
Swapped: F>R, C>R
Original: F>C>R

Table 2
Experiment 1: Old(Original or Swapped) vs. New

LAST NAME TYPE	Common	Famous	Rare
False Alarms (“original” or “swapped” /new)	0.43	0.23	0.20
Hits (“original” or “swapped” /original or swapped)	0.77	0.88	0.66
d’	1.00	2.20	1.47

Table 3
Experiment 2: Percent Correct Responses to Judgment on last name

CONDITION	common	famous	rare
new	.64	.83	.83
old	.72	.90	.72

Significant comparisons
New: F>C, R>C
Old: F>C, F>R

Table 4
Experiment 2: Judgment (Old vs. New) on last name (preliminary judgment) SDT

LAST NAME TYPE	Common	Famous	Rare
False Alarms ("old" /new)	0.36	0.17	0.17
Hits ("old" / old)	0.72	0.90	0.72
d'	1.18	2.63	1.75

This SDT analysis was based on the responses subjects gave at the first decision: whether the last name was old or new.

Table 5
Experiment 2:Percent Correct Responses to Judgment on name pair

Last Name	Common		Famous		Rare	
First Name	Common	Unusual	Common	Unusual	Common	Unusual
new	0.65	0.73	0.85	0.84	0.88	0.88
swapped	0.37	0.30	0.38	0.44	0.34	0.35
original	0.59	0.58	0.76	0.74	0.50	0.51

Table 6
Experiment 2: Judgment on First and Last Name (Original vs. Swapped) (secondary judgment) SDT

Last Name	Common		Famous		Rare	
First Name	Common	Unusual	Common	Unusual	Common	Unusual
False Alarms *("original" /swapped)*	0.50	0.48	0.59	0.51	0.51	0.49
	0.49		0.55		0.50	
Hits *("original" /original)*	0.77	0.81	0.84	0.81	0.69	0.69
	0.79		0.82		0.69	
d'	0.92	1.29	0.98	1.22	0.62	0.64
	1.10		1.01		0.63	

Table 7
Experiment 3: Percent Correct Responses to Judgment on last name

CONDITION	common	famous	rare
new	0.56	0.84	0.87
old	0.82	0.91	0.73

Significant comparisons
New: F>C, R>C
Old: F>C, F>R

Table 8
Experiment 3:Judgment (Old vs. New) on last name (preliminary judgment) SDT

LAST NAME TYPE	Common	Famous	Rare
False Alarms (“old” /new)	0.45	0.16	0.16
Hits (“old” / old)	0.82	0.91	0.72
d’	1.27	3.06	2.30

Table 9
Experiment 3:Percent Correct Responses to Judgment on name pair

Last Name	Common		Famous		Rare	
First Name	Common	Unusual	Common	Unusual	Common	Unusual
new	0.58	0.54	0.88	0.81	0.89	0.87
swapped	0.49	0.47	0.48	0.49	0.41	0.38
original	0.62	0.62	0.69	0.71	0.44	0.50

Table 10
Experiment 3: Judgment on Name Pair (Original vs. Swapped) (secondary judgment) SDT

Last Name	Common		Famous		Rare	
First Name	Common	Unusual	Common	Unusual	Common	Unusual
False Alarms *("original" /swapped)*	0.39	0.37	0.48	0.44	0.45	0.45
Average	0.38		0.46		0.45	
Hits *("original" /original)*	0.74	0.72	0.75	0.76	0.58	0.66
Average	0.73		0.76		0.62	
d'	1.28	1.29	0.86	1.13	0.44	0.84
Average	1.28		1.00		0.64	

Table 11
Experiment 4: Percent Correct Responses for each condition

Last	Common		Famous		Rare	
First	Common	Unusual	Common	Unusual	Common	Unusual
Original	0.68	0.68	0.85	0.75	0.57	0.64
Swapped	0.60	0.74	0.56	0.53	0.53	0.59

Table 12
Experiment 4: Signal Detection Analysis for Original vs. Swapped Decision
Averaged across subjects

Last Name	Common		Famous		Rare	
First Name	Common	Unusual	Common	Unusual	Common	Unusual
False Alarms *("original" /swapped)*	0.40	0.27	0.44	0.47	0.47	0.41
Average	0.34		0.46		0.44	
Hits *("original" /original)*	0.68	0.68	0.85	0.75	0.58	0.64
Average	0.68		0.80		0.61	
d′	0.80	1.28	1.35	0.85	0.30	0.68
Average	1.04		1.10		0.49	

Secondary Decision

First Name Comparisons

d'		uc-cc		uf-cf		ur-cr	
	#Subj	pld SD	Effect	pld SD	Effect	pld SD	Effect
Exp 1							
Exp 2	20	1.336	0.277	0.965	0.238	0.992	0.022
Exp 3	30	1.277	0.006	0.906	0.299	1.131	0.351
Exp 4	19	0.656	0.732	0.745	-0.685	0.614	0.627
Wgt Av			0.284		0.011		0.332

Last Name Comparisons

d'		F-R		C-R		F-C	
	#Subj	pld SD	Effect	pld SD	Effect	pld SD	Effect
Exp 1							
Exp 2	20	1.208	0.357	1.495	0.452	1.343	-0.182
Exp 3	30	0.269	1.543	0.434	1.244	1.290	-0.097
Exp 4	19	0.636	1.064	0.487	1.107	0.612	0.212
Wgt Av			1.067		0.977		-0.037

Figure 1

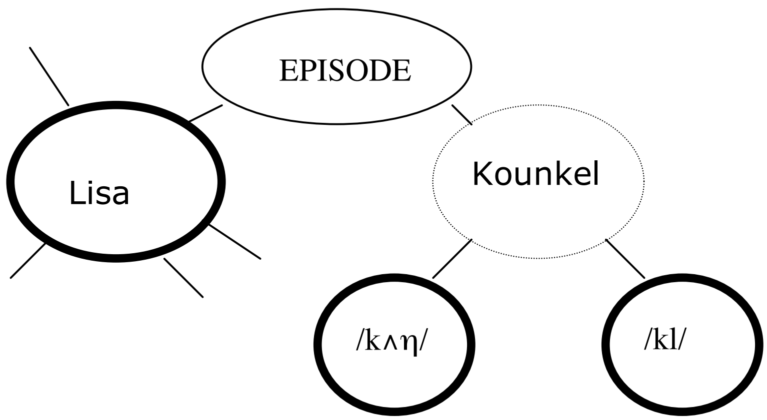

Figure A

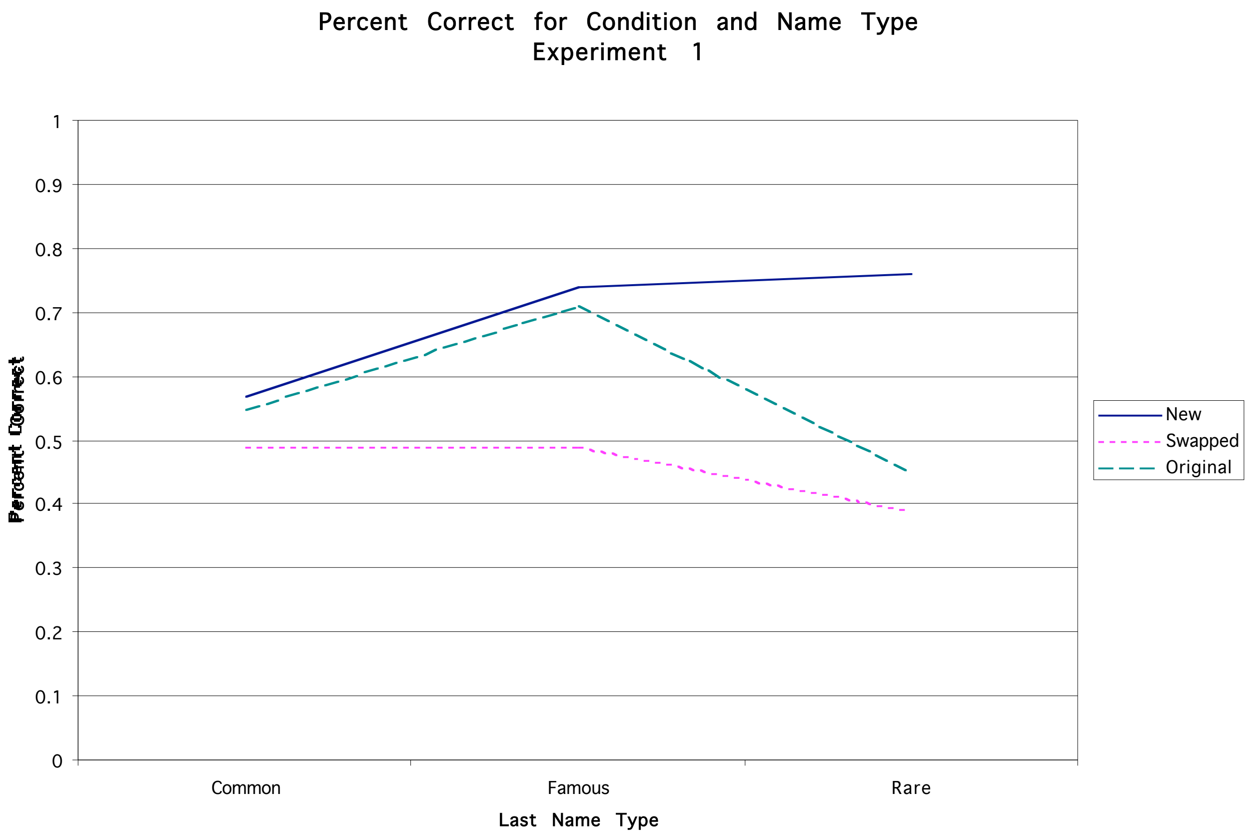
Percent Correct for Condition and Name Type
Experiment 1
Percent Correct
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Common
Famous
Rare
Last Name Type
New
Swapped
Original

Figure 2
Improvement in Discriminability (d') with First Name Unusualness
Experiment 2

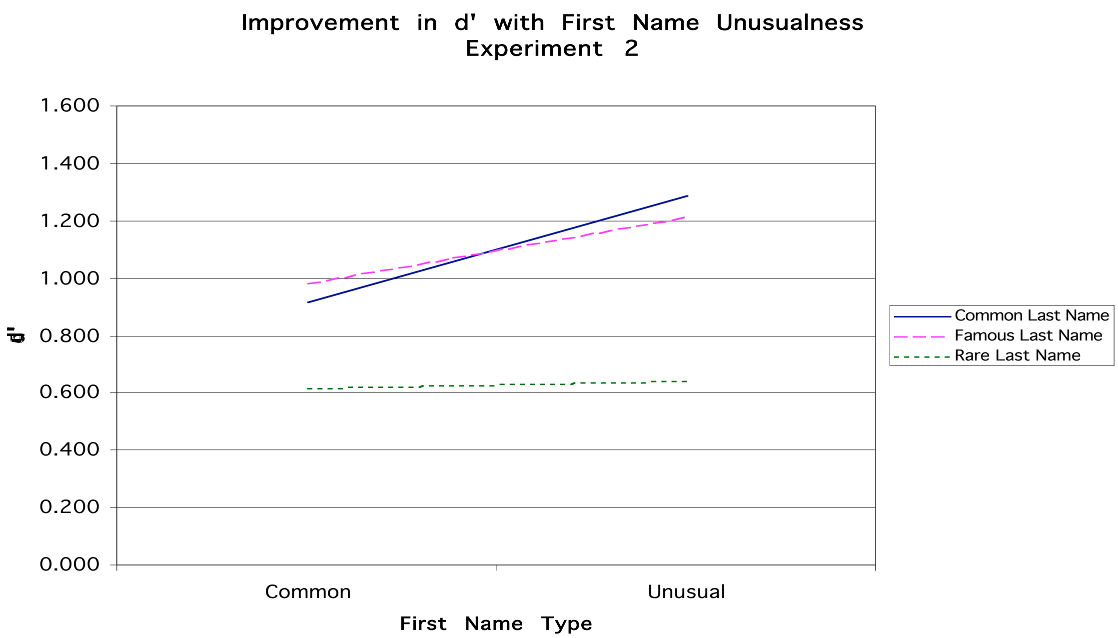

Figure 3
Improvement in Discriminability (d’) with First Name Unusualness
Experiment 3

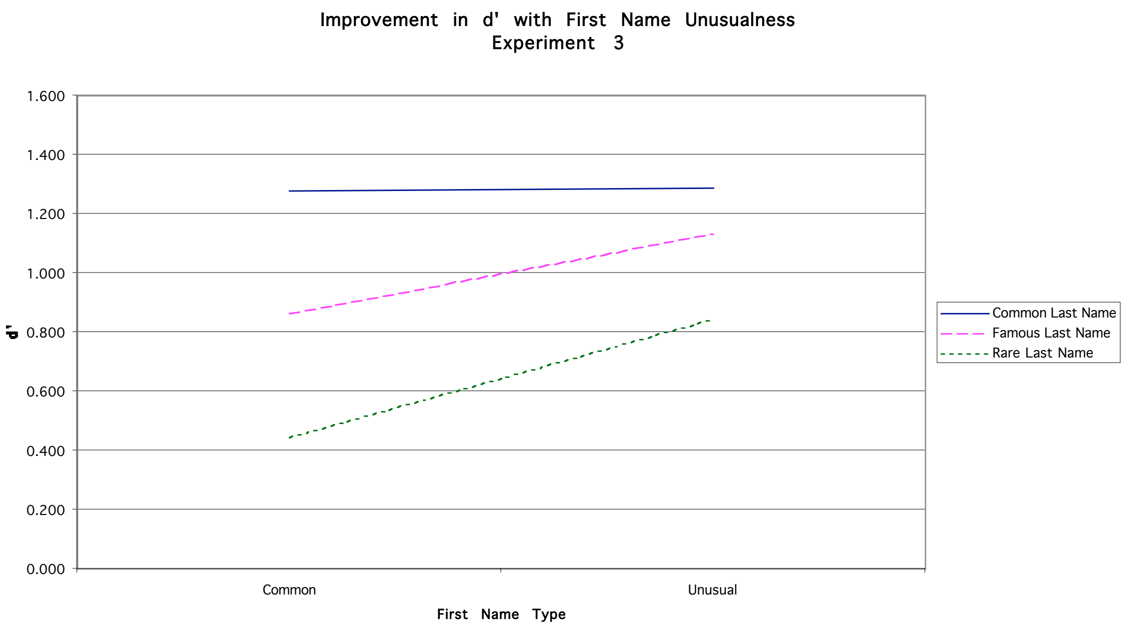

Figure 4
Improvement in Discriminability (d') with First Name Unusualness
Experiment 4