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FEATURE ARTICLE

A Study of Age-of-acquisition (AoA) Ratings in Adults

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A Study of Age-of-acquisition (AoA) Ratings in Adults

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Abstract

Certain word attributes such as frequency have been traditionally thought to be the best predictors of performance on a lexical task (e.g., picture naming). However, mounting evidence suggests that in certain lexical tasks, frequency effects maybe wholly or partly explained by age-of-acquisition (AoA). This paper reports the results of an age-of-acquisition study in which adults' ratings and response times were collected for 520 items (nouns). The resulting AoA ratings were (1) reliable, replicating the AoA effects reported in earlier studies, (2) valid, correlating highly with developmental data, and (3) the most powerful predictors of performance on a picture-naming task when compared to other predictor variables such as frequency and familiarity. Discussion focuses on alternative explanations of AoA effects, and some future goals.

Introduction

In psycholinguistic research, word frequency has proven to be an important determinant of performance in lexical tasks. For example, frequency is associated with both accuracy and latency in picture-naming tasks (e.g., Forster & Chambers, 1973; Humphreys et al., 1988; Jescheniak & Levelt, 1994; Oldfield & Wingfield, 1965). Intuitively it seems plausible that word frequency should affect naming latency, with the representations of words that are used more often becoming more rapidly accessible as a result of repeated activation. The classic, oft-cited study of picture naming by Oldfield and Wingfield (1964, 1965) reported a linear relationship between picture naming latency and log frequency. They selected 26 pictures that varied widely in Thorndike-Lorge (1944) name frequency and found that naming latency was negatively correlated (r = -.80) with frequency. Goodglass, Theurkauf, and Wingfield (1984) replicated this finding (cited in Snodgrass et al, 1996).

However, there is an increasing body of evidence suggesting that, at least in some tasks, apparent frequency effects may be wholly or partly accounted for by age-of-acquisition (AoA), that is, the estimated age at which a word is usually acquired (e.g., Brown & Watson, 1987; Carroll & White, 1973a; Gilhooly & Gilhooly, 1979, Morrison & Ellis, 1995). Most researchers agree that by their very nature, frequency and AoA are highly correlated: i.e., high-frequency words tend to be learned earlier in life than are low-frequency words. However, some investigators have suggested that AoA is actually a more powerful predictor than frequency, and that frequency effects

often disappear when their overlapping variance with AoA is controlled. Therefore, in the absence of AoA as a predictor variable, frequency may emerge as an apparently important predictor largely because of the variance it shares with AoA.

In the following section we will review the AoA literature to date. Broadly speaking, the methods used to obtain AoA data in the literature can be grouped into two classes. One class relies on the data collected from vocabulary tests and/or parental reports of children's abilities. Such methods are used to determine the "real" age at which words are acquired, i.e., an objective measure of age-of-acquisition. However, given the difficulty of establishing an objective measure of age-of-acquisition (i.e., "real" AoA), most studies of AoA have used an alternative method, the "rated" AoA, i.e. subjective measures (adult ratings) of word learning age.

Literature Review: Adult behavioral data

Carroll and White (1973a) were the first to obtain rated AoA scores. In their study, 20 adults were asked to rate 103 picturable nouns on a 8-point scale where 1= prenursery (age 2-3), 2= nursery (age 3-4), 3= kindergarten (age 4-5), 4= first grade (age 5-6), 5= second to fourth grade (age 7-9), 6= fifth to sixth grade (age 10-11), 7= seventh to eighth grade (age 12-13), and 8= ninth grade and above (age 14+). Subjects were asked to estimate the age at which they themselves had learned each word. They also obtained picture naming latencies from 50 subjects (not subjects in the age-of-acquisition task), and word frequencies indices from the Thorndike-Lorge (1944) and Kučera-Francis (1967) word counts. The basic finding in this study was that age at which a word was learned is the chief determinant of naming latency, and word-frequency is only incidentally associated with naming latency. In addition, Carroll and White (1973a) assessed the reliability of the ratings obtained in their study, using Ebel's (1951) method, reporting a reliability coefficient of .97.

This was followed by a second study (Carroll & White, 1973b) with a larger ratings corpus in which the scale was expanded to afford greater discrimination at the lower end. Sixty-two undergraduate students were asked to rate 220 picturable nouns on a 9-point scale, where 1= age 2 (prenursery), 2= age 3 (prenursery), 3= age 4 (nursery), 4= age 5 (kindergarten), 5= age 6 (first grade), 6= ages 6 and 7 (second, third grade), 7= ages 9 and 10 (fourth, fifth grade), 8= ages 11 and 12 (sixth, seventh grade), 9= age 13+ (eighth grade and above). Their findings, which replicated their previous results, were that age-of-acquisition accounted for picture naming times [obtained from the earlier Carroll & White, (1973a) study] better than Kučera-Francis word frequency (1967). Once again, Carroll and White (1973b) tested the reliability of the ratings and found a high reliability coefficient of .98. This is a strong indication that there is high consistency of rating within the subjects who participated in the experiment. Winters et al (1978) altered and refined the Carroll and White (1973b) 9-point scale and reported an intergroup reliability (males versus females) of .93. In view of its high reliability as well as its predictive value, Carroll and White (1973a, 1973b) argued that age-of-acquisition might be a better predictor variable than word frequency in picture naming. Their results suggest that age-of-acquisition accounted for naming latencies even better than Kučera-Francis (1967) word frequency and was the only significant variable in multiple regression analysis.

Lyons, Teer and Rubenstein (1978) used Carroll and White's (1973b) refined 9-point scale to obtain AoA ratings from 33 adults who were asked to judge when they had first learned 150 6- or 7- letter nouns, all of fairly low frequency (1-32 occurrences per million in the Thorndike-Lorge, 1944, count). Their study investigated the effect of age-of-acquisition in the recognition of tachistoscopically presented words. Their findings showed that once word frequency was controlled, words judged to be earlier acquired had a significantly lower threshold than words judged to be later acquired. Rubin (1980), as part of a large-scale study of a broad range of word attributes, had 42 undergraduates rate 125 words for AoA using the revised Carroll and White (1973b) 9-point scale and reported similar results.

Gilhooly and Hay (1977) collected AoA ratings from adults, using similar instructions to Carroll and White, but altering the scale from 9 points to 7 points where 1= learned at 0-2 years and 7= learned at age 13+, with 2-year bands in-between. They had 40 undergraduate students rate 205 five-letter words. Gilhooly and Hay (1977) also looked at the intergroup reliability by correlating scores across male and female subjects and found a correlation of .96. Gilhooly and Gilhooly (1979) also conducted another set of four experiments on the effects of age-of-acquisition in verbal tasks (lexical and episodic memory tasks). In all the studies, multiple regression analyses were used to assess the relative effects of AoA as opposed to other potentially relevant word attributes. From their results, they concluded that early age-of-acquisition (and picture codability) facilitates retrieval from lexical memory (e.g., picture naming) but has no significant effect in episodic memory tasks (e.g., free recall and recognition tasks).

The most widely used rating corpus is the one compiled by Gilhooly and Logie (1980), who had 36 undergraduates rate 1944 nouns of varying length and frequency on the same 7-point scale employed by Gilhooly and Hay (1977); again subjects were told to judge the age at which they themselves had learned the words, in either spoken or written form. In addition to the AoA ratings, imagery, concreteness, familiarity and ambiguity measures were also collected. Gilhooly and Logie (1980) also used correlations with AoA ratings and other word attributes used in previous studies to assess reliability, and they reported an intergroup reliability of .98 across gender.

Morrison, Ellis and Quinlan (1992) re-analyzed the data from Oldfield and Wingfield (1965) and included three variables in their re-analyses: an estimate (i.e., rated AoA) of the age at which the name was acquired (the word's age-of-acquisition), a count of the word's frequency (from Kučera-Francis, 1967), and one measure of length (the number of phonemes in the name). From these re-analyses it was shown that age-of-acquisition accounted for the original Oldfield and Wingfield (1965) data better than log frequency. Following the findings from the re-analysis study, Morrison et al., went on to conduct their own study in an attempt to see whether AoA or word frequency was the most important determinant of naming time. They presented 58 pictures (from Snodgrass & Vanderwart, 1980) to 20 subjects and analyzed the data from 48 pictures (after removing 10 items with high rates of naming error). They found that age-of-acquisition and word length in phonemes both had significant effects on naming latencies, whereas Kučera-Francis frequency in print, imageability, and rated prototypicality (for membership in natural or artificial categories) were not significant in the multiple regression.

Snodgrass and Yuditsky (1996) also obtained AOA ratings for 260 items used as stimuli in their picture naming study. The items were divided into two sets and were randomly ordered and printed on rating sheets. There was a variation of the task, in that subjects saw both the word and the matching picture. The same instructions and scale as those used by Carroll and White (1973b) were used here. The subjects were asked to rate each word and they were told that the picture accompanied the word so that the meaning of the word would be clear. Data from 78 subjects was analyzed. Of these subjects, 57 were native English speakers and 21 were nonnative English speakers (who were asked to rate in their native language). Both groups rated their fluency very high. In order to compute the reliability of the ratings, correlations between the first and the second ratings of the repeated items were computed (r= .96). Snodgrass and Yuditsky (1996) also reported data from naming times were collected for 250 of the Snodgrass and Vanderwart (1980) pictures. The resulting naming times and correct naming rates were well predicted in multiple regression analysis by rated age-of-acquisition (collected specifically for that study), better than either rated familiarity or frequency in print. It was also found that these naming times were also well predicted by one or another measure of codability (name or concept agreement).

In contrast, Lachman (1973) and Lachman, Shaffer, and Hennrikus (1974) reported significant independent effects of both rated frequency and rated AoA. It is perhaps worth noting an important procedural difference between the Lachman studies and earlier work: while other studies used objective (corpus-based) measures of word frequency, Lachman (1973) and Lachman et al. (1974) employed subjective ratings of word frequency.

Barry, Morrison and Ellis (1997) conducted a picture naming study, in order to observe the effects several variables on the naming speed. Data from a set of 195 pictures was used in the analyses, after excluding items with, for example, low name agreement. They found that the major determinants of picture naming speed were the frequency of the name, the interaction between AoA and frequency, and name agreement. They proposed that both AoA and frequency affect the process of activating a word's phonological form for its spoken production, which accounts for the interaction of the two variables. However, they also suggested that, within this process, the locus of the frequency is the lemma-to-lexeme connection strength, where as the locus of AoA effect is more likely at the level of the lexeme itself.

Most investigations of picture and word recognition involving AoA rely on the norms obtained by Gilhooly and Logie (1980). The few studies in which new ratings have been collected have relied on either the 7-point Gilhooly & Logie (1977) or the 9-point Carroll and White (1973b) revised scale, both of which are accepted as standard methods of representing word learning age in the AoA literature.

To summarize, many studies have obtained AoA ratings from adults, and have repeatedly reported a significant and substantial effect on naming times, over and above associated effects of word frequency. However, it is less clear exactly what these AoA ratings are measuring. Are they really measuring the age at which a child acquires a particular word? How do these ratings compare with developmental data (such as vocabulary tests)?

Relationship with Developmental data (i.e., vocabulary tests)

In the age-of-acquisition literature, many of the same groups of researchers collecting AoA rating data from adults have also attempted to validate adult estimates of word learning age against more objective measures derived from developmental data, including texts by and for children, and performance by children on vocabulary tests.

Carroll and White (1973a) obtained objective data on word AoA from the children's word frequency counts, which were obtained from studies examining the frequency of occurrence of words known by children of different ages in reading and writing (Dale, 1948; Rinsland, 1945; cited in Morrison et al., 1997). Carroll and White compared their rated estimates with these objective measures and found a strong relationship between the two measures ($r = .847$), suggesting that estimated AoA from adults reflects actual AoA from children.

Another group of researchers (Lyons et al, 1978) explored the validity of their ratings by testing 40 first-grade children (ages around 6) on the meanings of the stimulus words. From their results they concluded that the procedure of rating the age-of-acquisition variable might be reasonably taken as an indicator of when children actually learn the words.

Gilhooly and Gilhooly (1980) presented two studies providing evidence for the validity of ratings. In the first study, words for which objective norms were available were taken from a standardized vocabulary test and naïve subjects rated these words for age-of-acquisition. The correlation between the age ratings and the age norms were obtained. This correlation showed that the adult ratings agreed closely with the rank order of the vocabulary test words, an order based on age norms ($r = 0.93$). In the second study, words that had already been rated on age-of-acquisition by adult subjects (Gilhooly & Hay, 1977) were given as a vocabulary test to children of varying ages (i.e., ranging in age from approximately 5-21 years). The responses of the different age groups were then used to calculate objectively based estimates of age-of-acquisition. These estimates were then correlated with the subjective ratings ($r = 0.84$). In both these experiments, multiple regression analyses indicated that rated age was the major independent predictor of the objective age-of-acquisition indices, when compared to other predictors such as word frequency and word length.

Walley and Metsala (1992) presented further evidence that children's estimates of their own AoA were valid. They asked two groups of 20 children (mean ages 5:0 years and 7:10 years) to estimate the age at which they had learned, thought they had learned, or thought they would learn, words that were read to them. These were examined alongside adult ratings that had been collected in an earlier study (Walley & Metsala, 1990). Results yielded correlations between young children and adults' ratings of .88, between older children's and adults' ratings of .90, and between younger children and adults' ratings of .91. The similarity between children and adults' ratings was taken as evidence that even very young children have considerable meta-lexical knowledge.

Working from a slightly different perspective, Gathercole and Adams (1995) set out to examine how closely adults' ratings correspond with parents' judgments of when their children learned words. Comparing the parents' estimates with a more objective measure of whether or not their children knew the words, Gathercole and Adams reported a high degree of concordance between the estimates and the objective scores, indicating that parents had an accurate knowledge of their child's vocabulary. In addition, they found a close relationship between the parents' estimates and those made by the adult (college age students) subjects.

Morrison et al (1997) collected some "objective AoA norms", derived from a vocabulary test (i.e., a picture naming task) performance of children aged between 2:6 and 10:11 years, including a whole host of ratings for 297 picturable nouns on several word attributes (such as adult AoA ratings etc.). These researchers found a close correspondence between the ratings and the objective AoA derived from an examination of children's vocabulary development ($r = 0.76$, $p < .05$).

There are also data from a longitudinal diary study of vocabulary development, which suggests that AoA ratings accurately reflect word-learning age (Jorm, 1991). Jorm recorded the age at which his daughter first said the 94 picturable noun labels from Carroll and White (1973a) set. Her AoA ratings correlated highly with Carroll and White 's adult ratings ($r = .82$ at 9.6 years; $r = .83$ at 11.6 years).

Finally, D'amico and colleagues (in press) examined picture naming and lexical access in Italian children and adults. This was a normative study where the performance of 34- Italian speaking children and 50 adults' were compared on a timed picture naming task. Although, the children were substantially slower and less accurate than the adults, child and adult performance was highly correlated and their performance could be predicted by similar lexical predictors. Adult ratings of AoA had strong effects on both children and adults (and reduced or

eliminated the effects of frequency in regression analyses). However, an objective measure of AoA (obtained from the Italian MacArthur CDI) [the original English version used in the present study] only affected children's performance (and did not eliminate frequency effects in regression analyses).

To summarize the main findings in the AoA literature, it appears that the ages of acquisition ratings obtained from adults are a reliable measure, as subjects are consistent in their ratings for items. Also, when compared to developmental data, these adult ratings are highly correlated, which supports the claim that the AoA ratings are a valid measure of real word learning age. In addition, these studies also report data that AoA ratings are arguably the best predictors of picture naming latency. Results from some studies also report that other than word-learning age, attributes such as imageability, frequency, etc., also play a significant role in predicting the picture-naming latencies.

The Present Study: Age-of-acquisition (AoA)

In this paper, we will discuss results of a timed picture-naming experiment conducted with adults, using new subjective ratings of AoA together with a series of other predictors. There were several purposes to collecting the age-of-acquisition rating data from adults.

A first reason for undertaking this project was to replicate the AoA effects obtained in the previous studies (Carroll & White, 1973b; Snodgrass et al, 1996), using a larger stimulus set. It has been reported that the adult ratings were a very reliable and a valid measure of real word-learning age. We wanted to verify if the data obtained from the current study (with larger stimulus set) replicated the results from earlier work.

Second, we wanted to explore the effects of two methodological variations in the collection of AoA ratings. Most of the earlier studies (Carroll & White, 1973a, 1973b; Lyons et al., 1978 and others) have used only words to obtain the AoA ratings. However, Snodgrass et al., (1996) used accompanying pictures with the words as the stimuli for the AoA task where the goal was to clarify the meaning of the accompanying word. Both methods have therefore been used in the literature, but their effects have not been compared. We therefore compared AoA ratings for the same words, with and without an accompanying picture. In addition, none of the previous studies have collected response times along with the AoA ratings task. So this was another feature that was added to this study, i.e., it was a timed AoA study with the aim that we could examine the relationship between the rating responses and the rating times of the subjects.

Third, like many of the previous studies, the adult ratings obtained in the current study are examined in relation to two sets of developmental norms.

(a) The adult AoA ratings are compared to the items used in the MacArthur Communicative Developmental Inventories (CDI), i.e., an item analysis. These inventories are parental report instruments for evaluating early lexical and grammatical development (Fenson et al, 1993). These CDIs were developed to tap into parents' wealth of knowledge about their child's burgeoning linguistic abilities. This instrument comes in two parts: the Infant Scale (which examines word comprehension, word production, and aspects of symbolic and communicative gesture, in the period between 8-16 months), and the Toddler Scale (which looks at word production and the early phases of grammar, in the period from 16-30 months). Because the CDI is a parent report instrument, one might argue that these are subjective ratings, differing little from the AoA ratings that we want to validate here. However, a large number of studies have now shown that results of the CDI vocabulary checklists correlate highly with laboratory or home observations of the same children (see Fenson et al., for details).

(b) AoA ratings were compared to the developmental data collected from a vocabulary test performance of a cross-sectional sample of children (Morrison et al., 1997).

Fourth, we wanted to examine the relationship of the AoA ratings with picture naming latency and how they would compare to other predictors of lexical tasks such as word frequency and familiarity norms [see Table 1, Appendix B].

(1) Frequency norms include (norms obtained from 2 different sources)

> (a) American English printed word frequency norms for the target names from Kučera-Francis (1967) [the source used by Snodgrass et al., 1980], and
>
> (b) British English spoken word frequency norms for the target names (CELEX database, 1993)
>
> (c) The log natural values of the raw frequency scores for the target names (CELEX data base, 1993).

(2) Familiarity ratings were the same ones adopted by Snodgrass et al. (1980), based on a 5-point scale.

Finally, the present age-of-acquisition study was conducted to aid in the development of a normative database that will be useful for future studies of examining the processes implicated in understanding lexical access.

Methods

Subjects

Fifty-three monolingual (male = 30; female = 23), English speaking, right-handed undergraduate students participated in this study. All the subjects who participated filled out an initial screening questionnaire to verify that they met selection criteria for participation in this experiment. The selection criteria were that all subjects must be native English speakers who were not early bilinguals. In addition, the subject had to be right handed with no hearing impairments or cognitive deficits. All the subjects were recruited from the University of California, San Diego community and either received one-hour research credit or were paid $7.00 for participating in the experiment. The subjects' ages ranged from 19-40 years (Mean age = 23 years). The subjects were alternatively assigned to one of the two experimental conditions yielding 27 subjects (male = 12; female = 15) in condition 1 (word only) and 26 (male = 18; female = 8) subjects in condition 2 (picture & word).

Stimuli

A total of 520 picturable nouns comprised the stimuli for this study. The stimulus set was obtained from the International Picture Naming (IPN) project [Bates et al, 2000]. This IPN project is an international, collaborative, cross-linguistic study investigating lexical access using a picture-naming paradigm for a large set of picturable nouns and verbs. The stimuli used in the IPN study consist of black-and-white line drawings, which were scanned into the computer, so that the digitized stimuli could be presented electronically under tightly controlled timing conditions. The target names for these stimuli (operationalized as the names given by the largest number of adult participants in a timed naming task) have been coded for a variety of attributes such as word frequency, familiarity, length in characters, length in syllables, presence/absence of word-initial fricatives (which are known to reduce the sensitivity of the voice key in recording naming times), and (where available) imageability ratings. Table 1 (see Appendix B) contains the entire list of stimuli used in the age-of-acquisition experiment, along with data collected from a separate timed naming experiment, and with the other predictor/independent variables that will be used in the data analyses.

Design

There were two experimental conditions. In Condition 1 (word condition) the subjects saw only words. This paradigm was adapted from Carroll and White (1973b). In Condition 2, (picture-word condition), words were accompanied by pictures in the belief that the picture would facilitate the conceptualization of the word. The picture-word paradigm was adapted from Snodgrass et al. (1996). These two experimental conditions were used to determine any difference in age-of-acquisition ratings provided by the subjects, which could be attributed to stimulus presentation. Participants were randomly assigned to either the word-only or the word-and-picture condition. The stimuli were presented to each participant in an individually randomized order, to control for possible order effects. Participants were also encouraged to take breaks during the task to minimize the effects of fatigue.

The dependent measures in this experiment were the age-of-acquisition ratings of the participants and the time taken to make these ratings. All responses (ratings and the rating times) were recorded via a Macintosh computer using the PsyScope experimental control shell (Cohen, MacWhinney, Flatt & Provost, 1993). Judgment latencies were timed from stimulus onset. There was no arbitrary time-out window. Stimuli remained on the screen until the participant responded with one of the keys marked on the keyboard. The inter-trial interval was 1000 msec.

Procedure

Participants were tested individually in a quiet testing room. The procedure for both experimental conditions was the same. Participants were seated in front of the Macintosh computer and a keyboard. The stimuli were presented in a random order to each subject via a Macintosh computer system using PsyScope (developed by Cohen, MacWhinney, Flatt & Provost, 1993). Instructions for the AoA ratings were adapted from Carroll and White (1973b). Participants were told that they would see a stimulus presented one at a time on the computer screen and they were instructed to rate each stimulus they saw, on a 9-point scale (2, 3, 4, 5, 6, 7-8, 9-10, 11-12, 13+ years), which was marked on the keyboard. The subjects were asked to estimate the age at which they learned the word, in either spoken or written form.

At the end of the task, subjects were asked to fill out a feedback form listing out the strategies they used in this rating task. Finally, the subjects were debriefed about the experiment (see Appendix A for the exact instructions used).

Data Reduction

The dependent measures in this task were the participants' ratings and the computer recorded the times taken to make each response. The mean (M) and standard deviations (SD) of all the subjects' ratings and for each item were calculated for each of the two experimental conditions (i.e., word condition; picture-word condition). In addition, the mean RTs for each item was computed across all subjects.

Results

Examining differences between the 2 experimental groups

In the first set of analyses, t-tests were conducted to evaluate differences between the ratings from the two groups (word-only and picture-word conditions). There was a significant between-group difference ($t = 8.433$; $p < .0001$) in the subjects' ratings in the two groups, with the subjects in the picture-word condition consistently rating the stimulus as being learned later. A similar t-test was conducted between the response-times recorded for these rating responses in the two experimental groups; and these results revealed no significant differences. A pairwise correlational analysis was also conducted between the two conditions, for the rating responses only (since there were no significant differences between the rating times for the two groups). These comparisons yielded a high correlation between the two groups for the AoA ratings ($r = 0.93$, $p = .0000$). Despite the significant differences between conditions for the rating responses, the high correlation suggests that subjects in the two groups followed a similar developmental trend in rating the items. Also, the comparisons (correlational coefficients) of the ratings from the two groups with other variables (earlier AoA rating studies, developmental data) were nearly equal. As a result, the rating responses and the rating times from the two groups were collapsed across the two groups (word only and the picture & word condition) for the convenience of the reader, as the differences in rating appear not to affect the analyses described later in this paper.

Examining the relationship between the AoA ratings and the rating times

A correlational analysis was conducted between the subjects' ratings and the response times that were recorded (i.e., time taken to rate each item). The analysis revealed a significant linear correlation between the AoA ratings and the response times [$r = 0.43$, ($p = .0000$); see Table 2, also see Figure 4]. This indicates that there was a tendency for earlier acquired words to be rated more quickly than the later acquired words. The low magnitude of the correlation could be due to the non-rigorous enforcement of the timing by the experimenter for the subjects who participated in the study.

Replication of previous studies

A major aim of this study was to assess the reliability of the AoA ratings, by comparing mean (AoA) ratings from the present study to AoA rating of Carroll and White (1973b) and Snodgrass et al (1996). A pairwise correlation was done comparing the AoA ratings for all the common items in the present study with two previous studies: Carroll and White (1973b) [$r = 0.89$; $p = .0000$] and Snodgrass et al. (1996) [$r = 0.89$; $p = .0000$]. From the correlations obtained, there appears to be a high correspondence among the ratings from the present study and the previous studies (see Figure 1a & b). This strongly suggests that the ratings elicited in our study were reliable and consistent; i.e., we appear to be getting AoA effects similar to those obtained in the earlier studies.

Correlations with developmental data

Data from the present study were compared to two sets of developmental norms. We compared the AoA ratings and the rating times to developmental norms that were from two different sources. First, we compared the data to the MacArthur Communicative Development Inventories (CDI), parent report forms that use word checklists to estimate children's vocabulary size between 8-30 months of age. Here, the 520 words used in the present experiment were grouped into three sets of items. All items that appeared on the 8-16 month infant checklist (142 items) were coded as 1. Items that appeared only on the 17-30 month toddler checklist (57 items) were coded as 2, and all the remaining items in AoA dataset (321 items) were coded as 3. These ratings were then correlated with the age ratings and the rating times obtained from the age-of-acquisition experiment. A correlation coefficient of 0.61 ($p = .0000$) was found for the AoA ratings and .286 ($p < .001$) for the rating times. This shows that there is a fairly good correspondence between the adult AoA ratings, and to a lesser extent between AoA rating times and the MacArthur CDIs (see Table 2; also see Figure 2).

In addition, a correlational analysis was also done using child performance data (Morrison et al., 1996) with the ratings responses($r = 0.69$; $p = .0000$) and with the ratings times ($r = .098$; $p < .001$) obtained from the present study. The developmental data were obtained from Morrison et al (1996) for a subset of our items that overlapped with their stimulus set.

This was a picture naming task, with a cross-sectional sample of children ranging from ages 2:6-2:11 to 7:6-7:11 years. As can be seen, there is a strong correlation between the AoA ratings from adults and the Morrison et al. objective AoA data (see Figure 3; also see Table 2). However, there was no strong correlation between the rating times and objective AoA (Morrison et al., 1996) data.

Relationship with AoA ratings and rating times with other word attributes

A second set of correlational analyses was conducted among the picture naming times collected in a previous study for all the 520 items (Bates et al, 2000), and the AoA ratings and the rating times obtained from the present experiment, frequency norms (Kučera-Francis, CELEX database) and familiarity ratings (Snodgrass et al., 1980). The analyses showed that naming times were correlated with AoA ratings at 0.61 ($p = .0000$) [Figure 7]. The comparisons with frequency norms revealed a correlation coefficient of -0.28 ($p < .005$) with the Kučera-Francis frequency norms (Figure 5a), and correlation coefficient of -0.31 ($p = .0000$) with the CELEX database frequency norms (Figure 5b) and -0.34 ($p = .0000$) with log frequency values [CELEX database] (Figure 5c). Finally, the correlation coefficient for the comparison between naming times and familiarity norms was -0.45 ($p = .0000$) [Figure 6]. Thus, although the correlations were all significant, there were substantially higher correlations between AoA ratings and the picture naming times, followed by familiarity norms and frequency norms [also see Table 3].

The correlational analyses with AoA rating times and the other lexical variables (naming latency, frequency, familiarity) revealed some weak correlations (see Table 2).

Step-wise regression

In order to fully understand the power and efficacy of the data collected and also understand the nature of the relationship between AoA and other lexical predictors with naming performance, we conducted two sets of regression analyses. First, we wanted to control the potential confounds of the two AoA predictors (ratings and rating times), to see if there are additional effects of AoA response times on the picture naming data (latencies, naming responses) over and above the contribution of AoA ratings [see Table 4]. From the regression analyses it is apparent that AoA response times do not additionally contribute to the fit of the model once AoA ratings have already been used to account for the variance in the naming times and naming responses.

Second, another set of step-wise regression analyses was conducted to verify whether there are independent contributions of the lexical predictors (such as AoA, frequency) with picture naming data [see Table 5]. In the second set of regression analyses we carried out a step-wise regression in order to verify the relationship and the effects of AoA and frequency on naming latency and response. The predictor variables were AoA ratings and frequency (log values of CELEX raw frequency scores). These variables were selected as they showed a high correlation with the naming data. The other predictor variables that were included in the regression analyses were CDI objective AoA data and word syllable length as they have been used in previous studies to predict lexical performance (Bates et al., 2000). We did not include the other variables (e.g., familiarity ratings), despite their high correlation with the naming data, because we did not have norms available for these variables for all the 520 items used in this stimulus set. From the regression analyses we see that there are significant independent contributions of both frequency and AoA ratings in accounting for the variance in the naming data (see Table 5).

Discussion

In the present study, age-of-acquisition (AoA) ratings were collected from adults for a large corpus of items (either words, or pictures and words) along with the time taken to make these rating decisions, for 520 items used in a large picture-naming norming study. The results showed that participants in the picture-word condition actually rated items as being acquired later than participants in the word-only condition. The reason for this discrepancy is not entirely clear, but it may reflect a greater conservatism in AoA estimates when raters are confronted with a specific instantiation for the name that they are asked to rate. Despite this discrepancy, correlations over items on the word-only and word-picture conditions were so high that we conflated across the two conditions for all remaining analyses.

One of the aims in collecting these adult AoA ratings was to replicate the AoA effects on a larger dataset while using the Carroll and White paradigm (1973b). The high correlations with Carroll and White (1973b) and the Snodgrass et al., (1996) AoA ratings suggest that we were successful in replicating the effects obtained earlier by these two separate groups of researchers.

Secondly, we also wanted to validate these adult ratings against independent developmental measures - in this case, parent reports of infant and toddler

vocabulary (CDIs). The r-value of .63 indicates that there is indeed a close correspondence between these two measures. The additional comparison with children's data (r = 0.69) from the Morrison et al (1997) study again corroborates the conclusion that adult ratings do indeed reflect (at least in part) the age at which children learn words; hence, at some level, adults do know something about the age at which they learned a particular word. While there is no substitute for the real developmental data, these adult age-of-acquisition ratings are a reliable and valid measure that can be used when it is difficult to obtain the real word-learning data. In addition, the high correspondence between our AoA ratings and those obtained in earlier studies (including those obtained with objective measures) validate our decision to include the AoA ratings in development of a normative database. These ratings for the 520 items will be included in the International Picture Naming project database along with other indices such as word frequency, familiarity ratings etc., which will useful for future studies in lexical access.

Another goal in conducting the picture naming experiment was to examine the relationship of the naming times (Bates et al, 2000) with AoA ratings from the age-of-acquisition study and also with other word attributes (such as word frequency and familiarity ratings). The results showed that the AoA ratings were a powerful predictor of the naming times, higher than frequency norms and/or familiarity ratings. From our results, it also seems that familiarity ratings were slightly better at predicting the naming times, than the frequency norms. This pattern of results was similar to the results from both the Carroll and White (1973a, 1973b) and the Snodgrass and Yuditsky (1996). In Carroll and White (1973) there was a higher correlation between the AoA ratings and the picture naming times (r = 0.77) than between naming times and frequency norms (r = 0.57). Snodgrass et al. (1980,1996) also found that their response time data from the picture naming study correlated better with AoA ratings (r = 0.59) than with the frequency norms [Kučera-Francis, 1967] (r = - 0.28).

To take this discussion a step further, in the AoA literature it has often been reported that frequency is just AoA data in disguise. That is, once AoA effects are controlled in the naming data there should be no effects of frequency (based on regression analyses). To test this hypothesis, we conducted step-wise regression analyses to examine the independent effects of AoA and frequency. Although we confirmed that AoA ratings are significantly better predictors of naming performance (controlling for frequency), we also found that frequency effects were not completely obliterated when AoA ratings were already entered into the model. In fact, it appears that there is an independent contribution (significant) of frequency in accounting for the variance in the naming data. In other words, even though frequency and AoA have substantial overlap, we find that both measures make independent contributions to lexical access in a picture-naming task. Similar independent effects of frequency and age-of-acquisition in lexical access tasks have also been reported by other researchers (Ellis & Morrison, 1998; Gerhand & Barry, 1998, 1999).

It seems relevant at this point to speculate about the reasons why these subjective adult ratings are among the most powerful predictors of picture-naming times. It has been consistently found that adult ratings of the word learning age are a very important variable that predicts performance on a lexical processing task. However, the reason for this strong relationship is still unknown. Why are these ratings so effective in predicting lexical performance? Examining the subjects' feedback form (the questions asked at the end of the experiment) revealed that most subjects reported they were using more than one strategy to rate these items, such as memory recall (they remembered when they learned a specific item), deduction and logic (they assume that certain words are learned at or by a certain age and rate those items accordingly), guessing, etc. As illustrated by these subjects' feedback, there clearly there isn't one single obvious mechanism or theory to explain these results. However, several accounts have been offered to explain the relative advantage of AoA ratings over other word attributes such as frequency and familiarity.

Brown and Watson (1987) have proposed that early-acquired words may be stored in their entirety within the phonological lexicon, whereas the representations of late-acquired words may be more fragmented in nature. The extra time required to assemble the dispersed representation of a late-acquired word account for its slower processing (cited in Jorm, 1991).

Some other researchers have suggested instead that subjective AoA is a composite variable that embodies elements of frequency, familiarity, imageability and so on. For example, Paivio et al. (1989) [cited in Morrison et al, 1997] found that rated AoA loaded on 3 out of 7 factors in a factor analysis of naming and imaging whereas the Kučera-Francis frequency norms loaded on only a single factor.

Other researchers have suggested that AoA ratings, true learning age and naming latencies are all correlated because they reflect a common set of

causal factors. This argument seems to be supported to some extent by participants' reports of the strategies that they employed in the rating the items. Most reported that they used a combination of strategies that included deduction (i.e. reasoning about the age at which an item ought to have been learned) as well as actual memories of early word use. In some cases where the participants did not know when they learned the item, they report that they simply guessed.

Perhaps the most interesting explanations come from investigators who are persuaded that AoA ratings truly reflect (directly or approximately) the age at which words were learned. In particular, some investigators have proposed a "first-in" approach in which the earliest acquired words have a privileged status in the mental/neural lexicon. In some computational models of word learning, the first-acquired words help to define and constrain all subsequent learning, influencing the 'first principal components' in a high-dimensional vector space of sound and meaning. The viability of this approach has been demonstrated in computational models of word learning in which the variance contributed by age-of-acquisition is separate from the variance contributed by frequency [Ellis et al, 2000; Zevin et al, (submitted for publication); Smith, et al., 2001]. If this approach were correct, it would justify further investments in age-of-acquisition measures for the study of word learning in children and lexical processing in adults.

Conclusions

In this section, a summary the results from the present study (age-of-acquisition study) will be provided along with some of the future implications and directions for the AoA rating studies and studies of lexical access.

First, a comparison of the AoA ratings collected in the present study with previous studies clearly tell us that we were able to replicate the effects found in these earlier studies. Also, a comparison of the AoA ratings with MacArthur CDIs and objective AoA data (Morrison et al, 1997) indicates that these adult ratings do to a relatively large extent reflect real word learning age. In addition, the AoA ratings were the best predictors of performance on lexical tasks i.e., higher correlation with picture naming latency, than word attributes such as frequency and familiarity norms. However, we also found that there were independent and significant contributions of both frequency and AoA.

Future goals include trying to understand the efficacy of the age-of-acquisition ratings with bilingual and multilingual populations, i.e., for example, whether the AoA ratings collected in one language (for example, the dominant language or L1) is a good predictor of performance on the lexical processing tasks (like picture naming) in the second language or L2. If indeed, we are making the AoA ratings at the conceptual level and not at the superficial lexeme level, than it would be interesting to see if the AoA ratings obtained in L1 can be used are useful a measure to predict performance on tasks such as picture naming in L2. In addition, it would be interesting to see what role and effects age-of-acquisition plays in predicting performance in language impaired populations.

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Appendix A: Instructions

Experiment 1: Age-of-acquisition- Instructions and debriefing form

" You will see a list of words (or words and pictures) presented one at a time on the computer screen. We need your estimate of when in your life you think you first learned the meaning of each of the words that you see, i.e., first learned the word and its meaning either in spoken or written form. We are aware that it might be difficult to remember exactly. Therefore please give us your best estimate of when you think you learned the meaning of the word, even if you have to guess.

You are provided with a 9-point scale to give your best estimate of the age you acquired the word.

The 9-point scale is:

Age	**Grade**	**Keyboard Code**
2 years (and under)	Prenursery	1
3years	Prenursery	2
4 years	Nursery	3
5years	Kindergarten	4
6years	First Grade	5
7-8 years	Second, Third	6
9-10 years	Fourth, Fifth	7
11-12 years	Sixth, Seventh	8
13+ years	Eighth and above	9

Respond to each word by pressing any of the nine keys specified on the keyboard. Try and respond as quickly as you can. Also, since you won't be able to change your responses, be careful that the response you give is what you wanted to choose.

You may take a break whenever you wish. Press the space bar to pause the experiment and press the space bar again to resume the experiment."

Subject Feedback form

Please describe in a few sentences any thoughts you have about the experiment. Please try and answer all the questions.

(1) What strategies did you use to rate the objects?

(2) Did you use all the keys in the range? If not what were the keys you used?

(3) How did you rate the ambiguous words? What strategies did you use? [word condition only]

(4) Did the pictures help make the task easier (i.e., clarify the meaning of the words) [Picture-word condition only]?

(5) Did the task get easier with practice and familiarity?

(6) Any additional comments?

Appendix B: Tables

Table 1 consists of the stimuli used in the AoA study, Mean and SD of the AoA ratings, Mean RTs for the ratings, AoA ratings from Carroll & White ('73) and Snodgrass et al ('96), MacArthur CDIs coding, mean objective AoA (months) [Morrison, '97], mean target RTs and % subjects using target name from the IPN study, word-frequency norms from Kučera-Francis, '67, word-frequency norms (raw scores) and natural log values (CELEX, '93), word-familiarity ratings (Snodgrass,'80) and number of syllables in each word.

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
1	accordion	7.77	2.51	2947	4.83	6.24	3		1179	66	1	1	0.693	2.15	4
2	acorn	5.62	1.93	2803			3		1242	78		2	1.099		2
3	airplane	4.51	1.64	2881	2.59	3.49	3		778	70	11	6	1.946	3.78	2
4	alligator	5.24	1.95	3122	3.69	4.86	2	23.40	881	90	4	2	1.099	1.65	4
5	anchor	6.34	2.07	3243	4.88	2.74	3		951	96	15	6	1.946	1.60	2
6	ant	3.73	1.37	2855		2.55	2	62.50	1171	88	6	12	2.565	2.62	1
7	antlers	6.48	2.16	3398			3		1186	72			0.000		2
8	anvil	9.44	3.31	3388			3		1239	48		1	0.693		2
9	apple	3.09	1.10	5590	1.91	2.25	1	22.10	810	98	9	30	3.434	3.98	2
10	aquarium	6.69	2.04	3647			3		1005	48			0.000		2
11	arm	3.04	1.21	2044			1	38.50	923	82		210	5.352		1
12	arrow	5.36	1.74	2662			3		785	98		15	2.773		2
13	artichoke	8.06	2.74	3674		6.28	3		1397	54	0	2	1.099	2.29	3
14	ashtray	6.62	2.35	3044		4.95	3	140.00	1250	62	0	9	2.303	3.56	2
15	asparagus	7.93	2.40	2853		6.03	3		1388	76	1	2	1.099	2.68	4
16	ax	6.32	2.20	3275	4.38	4.97	3	62.50	1085	76	12	9	2.303	2.28	1
17	baby	3.02	1.03	2960			1		729	94		258	5.557		2
18	babybottle	3.66	1.84	3313			3		775	88		116	4.762		2
19	babycarriage	5.38	1.69	3226		4.10	1		1335	46		1	0.693	2.72	2
20	backpack	6.03	2.36	3125			3		836	100			0.000		2
21	badge	6.56	2.16	3037			3		1221	64		9	2.303		1
22	bag	3.93	1.12	3687			3		925	82		80	4.394		1
23	balcony	7.13	2.37	4014			3		1324	64		13	2.639		3
24	ball	3.07	1.54	2032	1.34	2.03	1	23.40	886	100	110	111	4.718	3.20	1
25	balloon	3.88	1.35	2323			1		702	100		6	1.946		2
26	banana	3.57	1.64	1979			1		808	100		8	2.197		3
27	bandaid	4.13	1.45	2397			3		743	92			0.000		2
28	banjo	7.43	2.11	2671			3		1036	80		0	0.000		2
29	barbecue	5.93	1.95	3020			3		1012	88		2	1.099		3
30	barrel	6.50	1.92	3681		5.37	3	74.50	882	94	24	21	3.091	2.02	2
31	basket	4.91	1.49	3576	3.12	4.16	1	38.50	832	98	17	24	3.219	2.18	2
32	bat	4.97	1.51	2429			2		764	96		14	2.708		1
33	bathtub	3.82	1.51	3342			1		966	78		2	1.099		2
34	bear	4.11	1.65	3586	2.36	3.65	1	50.80	804	82	57	16	2.833	1.98	1
35	beard	5.10	2.02	3304			3		1033	96		25	3.258		1
36	beaver	5.49	1.92	2652			3		1395	70		3	1.386		2
37	bed	2.98	0.99	2636		2.42	1	22.10	706	100	127	169	5.136	4.72	1
38	bee	3.76	1.07	2312			1		1207	66		17	2.890		1
39	beetle	6.00	1.94	2451			3		1122	44		42	3.761		1
40	bell	4.33	1.86	2966	2.36	3.60	3	44.50	703	100	18	27	3.332	2.20	1
41	belt	4.71	1.45	2365			2		812	98		26	3.296		1
42	bench	5.24	1.67	4732			2		896	94		23	3.178		1
43	bicycle	4.30	1.31	2942	2.45	3.74	1	23.40	731	70	5	5	1.792	3.78	3
44	binoculars	6.70	2.13	3767			3		1055	90		103	4.644		4
45	bird	3.29	1.18	2453			1		915	80		0	0.000		1
46	blimp	6.92	2.06	2786			3		1359	76		97	4.585		1
47	wood	4.28	1.29	3802			3		1174	54		7	2.079		1
48	boat	3.82	1.21	2671			2		1059	70		6	1.946		1
49	bomb	6.37	2.31	4087			3		989	88		41	3.738		1

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
50	bone	4.50	1.49	4199			3		872	100		69	4.248		1
51	book	3.66	1.28	2502	1.83	2.79	3	22.10	656	100	193	434	6.075	4.75	1
52	boot	4.47	1.54	2995		3.75	1	23.40	869	90	13	39	3.689	3.38	1
53	bottle	4.08	1.62	3088		3.58	1	38.50	956	88	76	116	4.762	3.72	2
54	bowl	3.72	1.47	2580		2.89	1	38.50	831	96	23	33	3.526	4.18	1
55	bow	4.87	1.61	2711		3.70	3	56.50	927	78	15	13	2.639	2.25	1
56	box	3.79	1.24	2697			1		753	100		102	4.635		1
57	boy	3.18	1.58	2140			1		956	90		349	5.858		1
58	branch	4.97	1.73	3969			3		1092	68		94	4.554		1
59	bra	7.96	2.45	4393			3		917	100		6	1.946		1
60	bread	3.56	1.16	2310		2.74	1	38.50	773	98	41	74	4.317	4.40	1
61	bride	6.26	1.91	3299			3		1168	86		12	2.565		1
62	bridge	5.19	1.72	4139			3		862	98		66	4.205		1
63	broom	4.63	1.45	2243			1		821	100		8	2.197		1
64	brush	3.79	1.29	3823		3.08	1	23.40	955	94	44	17	2.890	3.80	1
65	bus	4.18	1.51	3394	2.31	3.10	1	23.40	771	100	34	79	4.382	4.50	1
66	butter	4.59	1.36	2617			1		1036	96		27	3.332		2
67	butterfly	4.00	1.44	2192	2.97	3.58	1	23.40	720	100	2	10	2.398	2.92	3
68	button	4.24	1.40	2639			1		917	100	10	26	3.296	3.85	2
69	cactus	6.32	2.23	2936			3		933	96		3	1.386		2
70	cage	5.56	1.76	4281			3		963	90		16	2.833		1
71	cake	3.71	1.37	2487	2.06	2.73	1	23.40	789	100	13	34	3.555	4.02	1
72	camel	5.37	1.77	3045			3		892	96		25	3.258		2
73	camera	5.20	1.87	2643			2		725	100		36	3.611		2
74	can	4.19	1.33	2523			2		940	92		9	2.303		1
75	candle	4.91	1.45	3167		4.10	3	38.50	831	100	18	16	2.833	3.08	2
76	cane	5.60	1.57	3294			3		922	92		10	2.398		1
77	cannon	6.64	2.53	3062			3		1159	92	7	6	1.946	1.52	2
78	canoe	6.18	1.72	3421			3		1164	58		6	1.946		2
79	canopener	5.81	2.08	3621			3		1433	88		0	0.000		4
80	cap	4.93	1.58	2813		3.61	3	68.50	946	64	27	68	4.234	3.12	1
81	car	3.51	1.41	2529			1		751	100		354	5.872		1
82	carousel	6.93	2.70	3805			3		1121	58		1	0.693		3
83	carrot	4.00	1.22	2374		3.16	1	25.10	806	100	1	8	2.197	3.55	2
84	cassette	6.73	1.87	3711			3		875	78		34	3.555		1
85	castle	5.16	1.69	2524			3		893	100		27	3.332		2
86	cat	3.09	1.20	2005	1.36	2.50	1	23.40	766	94	23	67	4.220	4.22	1
87	celery	5.61	1.88	2442		5.00	3	140.00	1362	66	4	3	1.386	3.40	3
88	chain	5.71	1.92	3604			3		943	96		48	3.892		1
89	chair	3.51	1.25	2310	1.86	2.92	1	22.10	732	100	66	136	4.920	4.58	1
90	cheese	4.03	1.45	2805			1		843	82		31	3.466		1
91	cherry	4.30	1.28	2722		3.79	3	74.50	1077	90	6	7	2.079	3.38	2
92	chest	5.06	1.91	3322			3		959	94		48	3.892		1
93	chicken	3.82	1.07	2330		3.13	1		1010	68	37	41	3.738	2.42	2
94	chimney	5.02	1.59	2592			3		1169	92		10	2.398		2
95	church	4.48	1.96	3487			1		988	96		183	5.215		1
96	cigarette	6.51	2.63	3231	3.62	4.78	3	86.50	1016	92	25	71	4.277	3.65	3
97	city	4.89	1.41	2912			2		1158	82		257	5.553		2
98	clamp	8.22	2.56	3518			3		1823	30		3	1.386		1
99	clock	4.14	1.25	3130			1		772	98		39	3.689		1
100	clothespin	6.18	2.12	3209	3.31	4.95	3		1589	48	0		0.000	2.80	1
101	cloud	4.11	1.45	2888		3.13	2		1204	76	28	56	4.043	3.82	1
102	clown	4.21	1.60	2470		3.23	2	38.50	804	98	3	4	1.609	2.60	1
103	coat	4.40	1.38	2987		3.47	1	68.50	1010	56	43	61	4.127	3.88	1
104	coin	4.56	1.49	2830			3		1064	60		5	1.792		1
105	column	7.93	2.41	3707			3		1375	40		16	2.833		2
106	comb	4.16	1.36	2827			1		717	100		5	1.792		1
107	cookie	2.93	0.99	2154			1		1213	74		4	1.609		2

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
108	cork	7.33	2.23	3481			3		1354	78		5	1.792		1
109	corkscrew	8.09	2.87	3466			3		1509	38		1	0.693		2
110	corn	4.33	1.43	2372	2.94	3.50	2		837	100	34	24	3.219	3.50	1
111	cow	3.77	1.35	2036	1.90	3.11	1	23.40	1079	90	29	40	3.714	2.42	1
112	cowboy	4.59	1.42	2645			2		1263	78		6	1.946		2
113	crab	5.68	1.83	2762			3		1040	92		9	2.303		1
114	crackers	3.70	1.47	2810			1		1075	82			0.000		2
115	crib	3.93	1.45	3165			1		1127	82		1	0.693		1
116	cross	5.00	2.50	3436			3		793	100		22	3.135		1
117	crown	5.20	1.61	3437		3.98	3	56.50	945	90	19	24	3.219	1.52	1
118	cube	6.07	2.18	4166			3		1335	28		54	4.007		1
119	cup	3.31	1.24	1913	1.66	2.68	1	25.10	852	84	45	77	4.357	4.40	1
120	curtain	5.36	1.72	3133			3		980	60		0	0.000		2
121	deer	4.82	1.41	2489		3.98	1	86.50	1182	88	13	12	2.565	2.22	1
122	dentist	5.51	1.75	2625			3		1075	84		9	2.303		2
123	desert	5.74	1.84	4339			3		1173	66		41	3.738		2
124	desk	4.53	1.29	3127		3.92	3	86.50	975	100	65	91	4.522	4.32	1
125	diaper	3.53	1.45	3613			1		1189	46		2	1.099		3
126	dinosaur	4.39	1.74	2358			3		1012	98		5	1.792		3
127	doctor	4.19	1.49	2908			2		1076	82		184	5.220		2
128	dog	2.93	1.03	2614	1.55	2.23	1	22.10	702	100	75	115	4.754	4.60	1
129	doll	3.20	1.18	2378			1		1002	86		25	3.258		1
130	dolphin	5.33	1.61	3884			3		894	98		3	1.386		2
131	donkey	4.97	1.59	2629		4.35	1	50.50	1060	74	1	14	2.708	1.88	2
132	door	3.44	1.10	2453	1.97	2.55	1	22.10	719	100	312	386	5.958	4.68	1
133	dragon	4.89	1.47	2450			3		891	96		9	2.303		2
134	drawer	4.63	1.52	2679			1		994	100		24	3.219		2
135	dress	4.27	1.78	2771			1		840	100		87	4.477		1
136	dresser	5.42	1.70	3416		4.55	3		1163	48	1	5	1.792	4.52	2
137	drill	6.94	2.31	3218			3		1311	54		8	2.197		1
138	drum	4.93	1.80	2714			3		766	80		16	2.833		1
139	duck	3.71	1.40	2119		2.93	1		958	96	9	0	0.000	2.75	1
140	dustpan	6.01	1.91	2833			3		1490	58		1	0.693		2
141	eagle	5.51	1.92	2794		5.08	3		1213	58	5	9	2.303	2.42	2
142	ear	3.11	1.05	2302	1.82	2.13	1		681	100	29	88	4.489	4.50	1
143	earring	5.51	1.61	3296			3		1642	40		3	1.386		2
144	egg	3.94	1.65	2348			1		874	98		86	4.466		1
145	elephant	4.18	1.41	2821			1		837	98		24	3.219		3
146	envelope	6.00	1.71	2926	3.93	4.43	3	68.50	794	92	21	24	3.219	4.12	3
147	eskimo	6.58	2.35	3061			3		1206	78			0.000		3
148	eye	3.02	1.08	2171	2.00	2.13	1	44.50	700	96	122	523	6.261	4.88	1
149	fan	5.00	1.51	2990			3		865	96		17	2.890		1
150	faucet	5.87	2.25	3483			3		1130	82		2	1.099		2
151	feather	4.60	1.36	3035			3		977	96		21	3.091		2
152	fence	4.84	1.45	3256		3.73	3	62.50	819	98	30	30	3.434	3.02	1
153	finger	3.00	1.09	2265			1	23.40	775	96		123	4.820		2
154	fire	4.13	1.66	2153			3		854	96		162	5.094		2
155	fireman	4.49	1.54	2637			2		899	94		4	1.609		3
156	firetruck	4.50	2.13	4394			1		1066	62			0.000		3
157	fish	3.66	1.28	2240			1		777	98		163	5.100		1
158	fishingrod	6.03	1.71	3609			3		1169	52			0.000		2
159	flag	4.41	1.34	2718		3.72	2	38.50	847	100	16	26	3.296	2.90	1
160	flashlight	5.09	1.69	2960			3		975	96		5	1.792		2
161	flask	9.52	2.79	4019			3		1321	50		79	4.382		1
162	floor	3.90	1.40	2574			3		1594	50		76	4.344		1
163	flower	3.42	1.08	2233	2.15	2.68	1	22.10	754	100	23	93	4.543	3.88	2
164	flute	6.86	2.34	2754		5.45	3	92.50	1402	84	1	3	1.386	2.45	1

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
165	fly	3.89	1.13	2470			3		1080	90		36	3.611		1
166	foot	3.03	1.27	1938		2.08	1	38.50	758	98	70	326	5.790	4.78	1
167	football	5.12	1.90	3277		4.55	3		723	100	36	33	3.526	3.55	2
168	fork	3.76	1.48	2331	2.24	3.03	1	23.40	723	100	14	15	2.773	4.78	1
169	fountain	5.97	2.16	2836			3		966	84		12	2.565		2
170	fox	4.91	1.61	2708		4.00	3	38.50	975	84	13	15	2.773	1.95	1
171	frog	3.97	1.41	2368	3.15	3.48	1	23.40	751	100	1	9	2.303	2.48	1
172	funnel	7.62	2.61	3014			3		1243	76		2	1.099		2
173	garbage	4.67	1.73	3260			1		1123	42		4	1.609		1
174	gas	5.60	2.00	3377			2		1240	38		77	4.357		1
175	gate	4.62	1.48	4755			3		988	58		30	3.434		1
176	genie	6.39	2.31	3969			3		1214	86		1	0.693		2
177	ghost	4.39	1.32	2831			3		849	100		31	3.466		1
178	giraffe	4.54	1.38	2077	4.07	4.21	1	38.50	783	98	0	2	1.099	1.80	2
179	girl	3.02	0.99	2862			1		861	92		438	6.084		1
180	glass	3.71	1.22	2433			1		845	70		145	4.984		1
181	glasses	4.62	1.63	8540		3.76	1	23.40	758	96	29	32	3.497	4.00	2
182	globe	5.51	1.59	3165			3		883	98		11	2.485		1
183	glove	4.94	1.32	3107			2		848	100		19	2.996		1
184	goat	4.90	1.49	2287			3		972	94		28	3.367		1
185	gorilla	4.86	1.76	2067		4.50	3	62.50	944	70	0	3	1.386	2.05	3
186	grapes	3.93	1.21	3006			2		849	90			0.000		1
187	grasshopper	4.86	1.67	5715		4.28	3		1234	66	0	3	1.386	2.42	3
188	guitar	5.57	1.84	3158	5.41	4.32	3	62.50	870	98	19	7	2.079	3.58	2
189	gun	5.12	2.02	3303		4.05	3	44.50	709	88	118	99	4.605	2.68	1
190	hair	3.00	1.00	2166			1		999	98		199	5.298		1
191	hairbrush	4.89	2.04	3066			1		896	84		17	2.890		1
192	hamburger	4.43	1.78	2447			2		828	84		5	1.792		3
193	hammer	4.58	1.21	3008	3.55	4.46	1	25.10	724	96	9	11	2.485	3.48	2
194	hammock	7.29	2.54	3079			3		1378	82		1	0.693		2
195	hand	2.99	1.32	2558		2.24	1	50.50	723	92	431	724	6.586	4.82	1
196	handcuffs	7.20	2.35	3948			3		1113	86		2	1.099		2
197	hanger	5.53	2.15	3667		3.95	3		777	88	0	2	1.099	4.52	2
198	harp	7.08	2.46	3014		6.08	3	126.50	914	88	1	3	1.386	1.88	1
199	hat	3.51	1.34	2399		2.90	1	23.40	684	92	56	68	4.234	3.18	1
200	hay	5.12	1.53	3725			3		1198	78		15	2.773		1
201	heart	3.98	1.47	2999		3.32	3	50.50	720	100	173	164	5.106	3.72	1
202	heel	6.03	2.14	3198			3		1014	86		29	3.401		1
203	helicopter	5.70	2.03	3493		4.93	2	23.40	793	100	1	16	2.833	2.55	4
204	helmet	6.21	2.11	3678			3		921	96		13	2.639		2
205	highchair	4.14	1.78	3338			1		1205	82		0	0.000		2
206	hinge	7.83	2.88	3371			3		1349	72		4	1.609		1
207	hippo	5.33	1.54	2316			3		1133	52		1	0.693		2
208	hoe	7.39	2.58	3626			3		1346	72		3	1.386		1
209	hoof	6.17	1.94	2607			3		1088	88		8	2.197		1
210	hook	5.63	1.92	2915			3		919	100		37	3.638		1
211	horse	3.93	1.40	2447	2.67	3.53	1	23.40	809	100	117	132	4.890	3.55	1
212	hose	5.02	1.90	3567			2		983	94		4	1.609		1
213	house	3.20	1.12	2439		2.41	1		745	98	591	606	6.409	4.38	1
214	hydrant	7.04	2.83	2987			3		1155	68		0	0.000		4
215	icecreamcone	3.84	1.38	3674			1		804	50			0.000		2
216	igloo	6.90	2.54	3862			3		963	98		1	0.693		2
217	iron	5.73	1.87	3124	3.88	4.76	3	44.50	856	100	43	71	4.277	3.65	2
218	ironingboard	6.40	2.40	4264		5.08	3		1105	90		0	0.000	3.50	4
219	jack	7.86	2.70	3142			3		1512	70		6	1.946		1
220	jacket	4.12	1.26	3525			1		881	88		42	3.761		2
221	jar	4.81	1.54	2971			2		979	88		19	2.996		1
222	puzzle	4.77	1.54	2928			2		866	98		9	2.303		2

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
223	jumprope	4.72	1.46	3335			3		1111	84		0	0.000		2
224	kangaroo	5.60	1.96	2727	4.55	4.30	3	44.50	856	100	0	3	1.386	1.92	3
225	key	4.28	1.31	2359	3.38	3.50	1	23.40	738	88	88	86	4.466	4.85	1
226	king	4.60	1.25	2961			3		898	98		99	4.605		1
227	kite	4.57	1.58	2657			3		796	100		5	1.792		1
228	knife	4.17	1.61	2942	2.70	3.18	2	23.40	816	96	76	44	3.807	4.45	1
229	knight	6.19	2.30	3019			3		1318	76		13	2.639		1
230	knot	5.23	1.92	3025			3		1122	58		14	2.708		1
231	ladder	4.97	1.22	6263			2		988	100		16	2.833		2
232	ladle	7.87	2.80	2861			3		1212	52		1	0.693		2
233	ladybug	4.57	1.74	2161			3		1164	64		0	0.000		3
234	lamp	4.60	1.33	2957			1		835	92		35	3.584		1
235	lawnmower	6.13	2.04	3115			2		1166	94			0.000		2
236	leaf	4.02	1.18	2243			3		848	96		81	4.407		1
237	leg	3.26	1.40	2425		2.20	1	38.50	1019	74	58	175	5.170	4.65	1
238	lemon	4.43	1.53	2618	3.06	3.60	3	44.50	911	94	18	15	2.773	3.25	2
239	leopard	6.00	2.13	3001	4.18	4.95	3	68.50	1194	50	0	8	2.197	1.92	2
240	letter	5.10	1.23	3002			3		1030	68		206	5.333		2
241	lettuce	4.89	1.63	2622			3		1037	56		7	2.079		2
242	lightbulb	5.03	1.41	2914		4.00	1	102.50	737	92		0	0.000	4.18	2
243	lighthouse	6.52	1.80	3822			3		1197	92		3	1.386		2
244	lightning	5.20	1.69	3390			3		944	82		14	2.708		2
245	lightswitch	4.87	1.78	3431		3.87	3		966	64			0.000	4.58	2
246	lion	4.02	1.53	2793			1		812	98		25	3.258		2
247	lips	3.68	1.79	2155	2.82	3.75	2	50.50	696	94	17		0.000	2.00	1
248	lipstick	5.77	2.30	3023			3		803	100		7	2.079		2
249	lizard	5.23	1.81	2230			3		1155	86		4	1.609		2
250	llama	8.13	2.77	3065			3		1387	68		0	0.000		2
251	lobster	6.69	2.25	3267	5.28	5.30	3	86.50	1289	82	1	3	1.386	2.58	2
252	lock	5.21	1.64	2690		4.89	3		968	98	23	15	2.773	3.18	1
253	log	5.23	2.11	3253			3		975	74		11	2.485		1
254	magnet	5.81	1.93	3157			3		1189	94		3	1.386		2
255	mailbox	5.00	1.75	3010			3		846	84		2	1.099		2
256	man	3.16	1.04	2495			1		978	94		1629	7.396		1
257	map	5.48	1.79	3424			3		847	100		40	3.714		1
258	mask	5.12	1.60	2902			3		852	98		20	3.045		1
259	match	4.88	1.55	3020			3		910	96		57	4.060		1
260	medal	6.11	1.81	2982			3		1197	84		11	2.485		2
261	microphone	6.78	2.15	3472			3		1473	72		8	2.197		3
262	microscope	7.78	2.23	3382			3		1212	76		8	2.197		3
263	mirror	4.03	1.23	2570			3		873	98		49	3.912		2
264	mixer	6.60	2.30	3618			3		1367	36		2	1.099		2
265	monk	8.38	2.67	3291			3		1077	40		49	3.912		1
266	monkey	4.27	1.58	2778			1		794	100		18	2.944		2
267	moon	3.87	1.45	2259			1		804	94		59	4.094		1
268	moose	5.82	1.52	3029			2		1158	70		1	0.693		1
269	mop	5.47	1.72	3341			2		933	94		3	1.386		1
270	mosquito	5.68	2.09	2876			3		1436	50		5	1.792		3
271	motorcycle	5.96	2.08	3298		4.89	1	38.50	932	96	0	14	2.708	3.25	4
272	mountain	4.80	1.55	2824	3.21	4.25	3	62.50	921	94	33	84	4.443	2.70	2
273	mouse	3.94	1.30	2380			1		961	90		18	2.944		1
274	mousetrap	6.20	1.90	3154			3		1193	64		1	0.693		2
275	mushroom	5.49	1.81	2745		3.35	3	62.50	746	100	10	13	2.639	2.45	2
276	music	4.39	2.01	3273			3		1072	48		133	4.898		2
277	nail	4.67	1.42	3116			2		1086	98		25	3.258		1
278	neck	3.71	1.45	2458			3		1057	66		79	4.382		1
279	necklace	5.23	1.96	3469		4.45	1	50.50	821	82	2	4	1.609	2.88	2
280	needle	5.57	1.63	3971			3		1449	86		16	2.833		2

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
281	nest	4.57	1.15	2496			3		1059	70		17	2.890		1
282	net	5.19	1.39	3686			3		1004	96		21	3.091		1
283	nose	3.26	1.71	2559		2.38	1	56.50	721	96	60	81	4.407	4.52	1
284	nurse	5.07	1.94	3233			2		1039	94		49	3.912		1
285	nut	5.92	2.57	2877		5.50	2	114.50	1298	46	15	23	3.178	2.55	1
286	octopus	6.01	1.94	2932			3		841	98		2	1.099		3
287	onion	5.63	1.89	2413		4.08	3	68.50	1100	92	15	16	2.833	3.32	2
288	orange	3.60	1.32	2307		3.23	1	38.50	1098	94	23	20	3.045	3.34	2
289	ostrich	6.70	1.97	2580		5.55	3	102.50	1337	72	0	3	1.386	1.52	2
290	owl	4.60	1.37	2339		4.08	1	38.50	837	100	2	7	2.079	2.22	1
291	package	6.09	1.75	4444			3		1102	94		20	3.045		2
292	bucket	4.77	1.44	3364			2		875	66		20	3.045		2
293	paintbrush	4.99	1.68	2517		4.21	3	50.50	1033	76	1	1	0.693	2.78	2
294	palette	9.92	2.44	5752			3		1366	50		26	3.296		1
295	palmtree	6.60	2.44	3311			3		908	84			0.000		2
296	pan	4.54	1.70	2879		4.32	3	44.50	865	84		27	3.332	4.15	1
297	panda	5.61	1.98	2188			3		1071	36		1	0.693		2
298	pants	3.59	1.40	2396			1		757	86		16	2.833		1
299	paper	3.90	1.17	3402			1		930	84		225	5.421		2
300	paperclip	6.13	1.91	3414			3		1262	70			0.000		3
301	parachute	6.67	2.13	2598			3		1437	52		4	1.609		3
302	parrot	5.52	2.03	2458			3		910	76		4	1.609		2
303	paw	5.26	1.91	2917			3		1341	62		6	1.946		1
304	peach	4.52	1.52	2967	2.79	3.74	3	102.50	1247	66	3	6	1.946	2.90	1
305	peacock	5.92	1.97	2772			3		1010	80		4	1.609		2
306	peanut	4.42	1.25	3299		3.55	3		780	90	6	5	1.792	3.00	2
307	pear	4.40	1.46	2385			3		949	100		6	1.946		1
308	peas	4.32	1.73	2802			1		1201	54			0.000		1
309	pelican	6.83	2.35	2720			3		1102	68		2	1.099		3
310	pen	4.28	1.47	2799		3.35	1	44.50	753	100	18	26	3.296	4.78	1
311	pencil	3.89	1.01	3245		3.28	2	38.50	702	100	34	19	2.996	4.42	2
312	encilsharpener	5.94	1.91	3328			3		1617	52			0.000		5
313	penguin	5.53	1.91	3154			1		897	96		5	1.792		2
314	piano	5.19	2.11	2656		4.28	3	44.50	798	98	38	27	3.332	3.42	3
315	picture	4.58	1.61	2881			1		1009	80		174	5.165		2
316	pig	3.86	1.34	2347	2.94	3.15	1	23.40	855	100	8	43	3.784	2.18	1
317	pigeon	5.68	2.06	3476			3		1399	36		103	4.644		1
318	piggybank	4.60	1.36	3105			3		965	92			0.000		3
319	pillow	3.98	1.58	2485			1		867	100		19	2.996		2
320	pineapple	5.64	2.01	2921		4.89	3	74.50	871	96	9	3	1.386	2.95	3
321	pinecone	5.58	1.95	3114			3		1536	58		0	0.000		2
322	pipe	6.26	2.30	3823	4.07	4.53	3	74.50	866	92	20	31	3.466	2.90	1
323	pirate	5.40	1.68	2783			3		1118	86		5	1.792		2
324	pitcher	6.28	2.07	3415	4.07	4.82	3		1248	52	21	1	0.693	3.50	2
325	pitchfork	7.30	2.33	4046			3		1397	62		0	0.000		2
326	pizza	4.52	1.63	2932			1		973	100		2	1.099		2
327	plate	3.71	1.24	2629			1		1013	94		55	4.025		1
328	pliers	7.38	2.80	3478		5.64	3	126.50	1521	56	1	1	0.693	3.38	2
329	plug	5.27	1.54	2804		4.55	3		1241	92	23	9	2.303	4.18	1
330	policeman	4.63	1.77	2543			2		1132	54		38	3.664		3
331	pool	4.47	2.05	3347			2		871	72		41	3.738		1
332	popcorn	4.86	1.71	3242			2		745	98		1	0.693		2
333	popsicle	4.00	1.50	2602			2		1380	64			0.000		3
334	porcupine	6.21	2.09	2499			3		1291	92		1	0.693		3
335	pot	4.41	1.59	3284			3		1361	58		36	3.611		1
336	potato	4.71	1.51	3201	2.67	3.64	2	74.50	1214	84	15	36	3.611	3.46	3
337	present	3.93	1.85	3571			3		893	64		17	2.890		2
338	priest	6.51	2.73	2899			3		1165	90		49	3.912		1

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
339	pumpkin	4.26	1.56	2411			2		909	98		2	1.099		2
340	purse	5.42	2.38	3106			1		772	98		10	2.398		1
341	pyramid	6.97	2.16	2987			3		987	94		7	2.079		3
342	queen	4.82	1.76	2457			3		931	98		53	3.989		1
343	rabbit	3.91	1.53	2559	2.61	2.80	1	22.10	746	82	11	19	2.996	2.95	2
344	raccoon	5.52	1.74	2452		5.21	3	140.00	1079	76	1	0	0.000	2.20	2
345	radio	4.88	1.97	3701			1		1007	86		88	4.489		3
346	radish	7.18	2.71	2887			3		1768	42		1	0.693		2
347	rain	3.64	1.68	2601			1		891	80		72	4.290		1
348	rainbow	4.22	1.29	2935			3		1004	94		7	2.079		2
349	rake	5.67	1.82	3275			3		828	98		2	1.099		1
350	razor	7.03	2.20	3473			3		1089	92		9	2.303		2
351	recordplayer	5.54	2.10	2860		4.43	3		1040	80		0	0.000	4.40	4
352	refrigerator	4.68	1.86	2744		3.78	1		842	88	23	10	2.398	4.68	5
353	rhinoceros	6.31	2.44	3067		5.15	3	86.50	998	74	3	2	1.099	1.52	4
354	rifle	7.32	2.46	3096			3		848	70		99	4.605		1
355	ring	5.03	1.57	4365			3		785	100		3	1.386		1
356	road	4.24	1.52	2496			3		925	92		249	5.521		1
357	robot	5.89	1.87	2977			3		793	98		7	2.079		2
358	rock	3.73	1.35	2493			1		910	96		116	4.762		1
359	rocketship	5.91	2.00	3421			3		854	90		14	2.708		2
360	rockingchair	4.97	1.64	3580		4.28	1		878	66		0	0.000	3.25	3
361	rollerskate	5.74	2.22	2531			3		844	50		0	0.000		3
362	rollingpin	6.94	2.41	2981		4.68	3		1113	70		0	0.000	2.22	3
363	roof	4.68	1.24	3262			2		1094	92		56	4.043		1
364	rooster	5.02	1.72	2603		4.16	2		1175	54	3	1	0.693	2.22	2
365	rope	5.03	1.54	3049			3		810	100		42	3.761		1
366	rose	4.83	1.54	2772			3		870	74		21	3.091		1
367	rug	4.67	1.59	3396			3		964	68		15	2.773		1
368	ruler	5.08	1.26	2509		4.30	3	62.50	779	100	3	18	2.944	3.58	2
369	saddle	6.17	1.83	3411			3		1019	98		10	2.398		2
370	safe	5.82	2.12	5685			3		1243	74		7	2.079		1
371	safetypin	6.38	2.15	4357			3		1278	48		1	0.693		3
372	sailboat	4.87	1.69	4370			3		1076	76		0	0.000		2
373	sailor	5.73	1.79	3416			3		1031	90		12	2.565		2
374	salt	4.66	1.49	3196			2		972	72		37	3.638		1
375	sandwich	4.06	1.24	2341		3.13	2	38.50	775	100	10	0	0.000	4.45	2
376	saw	5.08	1.96	3508		4.40	3	68.50	863	98	352	1	0.693	2.92	1
377	saxophone	7.87	2.39	4584			3		1061	76		1	0.693		3
378	scale	6.79	2.10	3309			3		1387	50		82	4.419		1
379	scarf	5.89	2.02	3103			2		1116	98		12	2.565		1
380	scissors	4.37	1.40	2925		3.79	1	23.40	741	94	1	4	1.609	3.98	2
381	scorpion	7.12	2.28	3638			3		1252	86		2	1.099		2
382	screw	5.91	1.73	4623			3		1176	86		10	2.398		1
383	screwdriver	5.99	2.19	3331		5.24	3	68.50	1179	96	0	3	1.386	3.42	3
384	seahorse	6.32	2.42	2565			3		1132	72		0	0.000		2
385	seal	5.22	1.85	2925		4.95	3		1115	80	17	14	2.708	1.62	1
386	seesaw	4.66	1.54	3424			3		1196	72		1	0.693		2
387	sewingmachine	6.40	2.31	3662			3		1068	98		0	0.000		4
388	shark	5.23	1.63	2608			3		1014	92		20	3.045		1
389	sheep	4.44	1.69	2430		3.60	1	44.50	1269	56	23	40	3.714	1.85	1
390	shell	4.58	1.87	2930			3		1101	84		46	3.850		1
391	ship	4.31	1.57	2153			3		860	52		76	4.344		1
392	shirt	3.40	1.21	2235			1		1334	74		61	4.127		1
393	shoe	3.29	1.56	2276	1.94	2.72	1	22.10	737	98	14	79	4.382	4.62	1
394	shoulder	4.61	1.86	2891			2		1162	76		128	4.860		2
395	shovel	5.24	2.03	3276			1		858	98		4	1.609		2
396	shower	4.57	1.73	3675			2		897	84		21	3.091		2

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
397	sink	4.31	1.73	2548			1		984	92		15	2.773		1
398	skateboard	6.91	2.51	3210			3		823	100		1	0.693		2
399	skeleton	5.92	1.95	3618			3		817	100		12	2.565		3
400	skirt	5.50	1.98	2886		3.84	3	56.50	992	72	21	29	3.401	3.64	1
401	skis	6.24	2.21	3274			3		1039	78			0.000		1
402	skunk	5.19	1.85	2605		4.33	3	140.00	1044	98	0	0	0.000	2.30	1
403	sled	4.92	1.71	3466		4.68	2		1188	96	0	1	0.693	2.80	1
404	slide	4.13	1.51	3328			1		1003	96		12	2.565		1
405	slingshot	6.50	2.17	3096			3		1265	74		1	0.693		2
406	slipper	4.73	1.52	3185			2		1256	60		9	2.303		2
407	smoke	4.98	1.68	2998			3		1221	82		48	3.892		1
408	snail	4.39	1.26	4086			3		918	96		4	1.609		1
409	snake	4.57	1.69	2725	3.52	3.92	3	25.10	775	96	44	23	3.178	1.90	1
410	snowman	4.11	1.41	2800		3.18	2	23.40	920	98	0	0	0.000	3.15	2
411	sock	3.50	1.31	2270		2.44	1	23.40	712	96	4	18	2.944	4.52	1
412	sofa	5.20	2.02	2942		3.63	2		828	74	12	10	2.398	4.40	1
413	soldier	6.32	2.13	2969			3		1170	66		83	4.431		2
414	spaghetti	4.24	1.43	2683			1		903	94		5	1.792		3
415	spatula	7.11	2.44	3624			3		1472	72		0	0.000		3
416	spider	4.12	1.26	2695			3		907	98		7	2.079		2
417	spoolofthread	8.13	2.71	5580		4.67	3		1426	64		16	2.833	3.12	1
418	spoon	3.28	1.21	2802	1.97	2.45	1	22.10	777	98	6	15	2.773	4.50	1
419	squirrel	4.57	1.60	2627			1		1234	88		6	1.946		2
420	stairs	4.18	1.46	3065			1		1011	74		44	3.807		1
421	statue	6.13	1.95	3813			3		1214	90		23	3.178		2
422	steeringwheel	6.24	2.55	3625			3		1158	64		0	0.000		3
423	stethoscope	7.83	2.64	3531			3		1209	86		1	0.693		3
424	stocking	6.53	2.67	3306			3		1218	42		12	2.565		2
425	stool	5.26	1.67	3864		3.89	3	50.50	973	80	1	12	2.565	3.82	1
426	stove	4.78	1.61	2884			1		1122	72		20	3.045		1
427	strawberry	3.82	1.27	2272			2		1052	98		6	1.946		3
428	stroller	4.66	1.94	3162			1		1346	74		1	0.693		2
429	submarine	6.71	2.23	2951			3		1145	86		17	2.890		3
430	suitcase	5.52	1.64	4376		4.45	3	62.50	902	76	20	19	2.996	3.65	2
431	sun	3.13	1.01	2462		2.34	1	23.40	762	100	112	152	5.030	4.90	1
432	swan	5.58	1.63	3442		4.30	3	62.50	1049	70	3	7	2.079	1.97	1
433	sweater	4.58	1.78	2759		3.45	1		1122	52	14	15	2.773	4.48	2
434	swingset	4.63	2.01	3651			1		942	72		18	2.944		1
435	sword	5.22	1.61	2713			3		1084	92		17	2.890		1
436	syringe	9.33	2.49	3877			3		1169	60		16	2.833		2
437	table	3.60	1.12	2461	2.45	2.58	1	22.10	852	98	198	235	5.464	4.35	2
438	tail	4.14	1.35	2835			3		1383	74		36	3.611		1
439	tank	6.09	2.24	3070			3		1155	76		39	3.689		1
440	taperecorder	6.32	2.05	3141			3		1009	72		2	1.099		4
441	teapot	5.29	1.85	3457			3		1085	44		4	1.609		2
442	tear	4.52	1.69	4063			3		1134	48		59	4.094		1
443	teepee	5.77	2.36	2890			3		1167	66			0.000		2
444	teeth	3.51	1.14	2274			1		949	76		3	1.386		1
445	telephone	4.37	1.92	2737		3.03	1	23.40	752	72	76	105	4.663	4.80	3
446	telescope	6.64	1.88	2798			3		1011	96		8	2.197		3
447	television	4.23	1.68	2738	2.62	3.08	1	38.50	786	60	50		0.000	4.82	2
448	tennisracket	6.63	2.50	3050		5.30	3		963	56			0.000	3.62	4
449	tent	5.52	1.90	2812			3		744	98		44	3.807		1
450	thermos	6.42	2.45	3437			3		1289	80		2	1.099		2
451	thimble	6.98	2.40	3442		5.92	3	140.00	1198	88	1	0	0.000	2.48	2
452	thumb	3.29	1.25	2753			3		870	96		27	3.332		1
453	tie	5.01	1.85	3167			3		758	98		34	3.555		1
454	tiger	4.37	1.47	1959			1		1072	86		12	2.565		2

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
455	tire	5.18	1.80	2581			3		804	90		11	2.485		2
456	toaster	5.26	1.96	2612		4.58	3	50.50	860	96	0	1	0.693	4.08	2
457	toe	3.11	1.25	2052			1		1211	46		29	3.401		1
458	toilet	3.69	1.33	2673			3		825	100		28	3.367		2
459	tomato	4.51	1.63	2748		3.47	3	68.50	962	98	4	14	2.708	3.78	3
460	tomb	7.68	2.50	4129			3		1228	62		21	3.091		1
461	toothbrush	3.50	1.22	2903		3.00	1		811	100	6	2	1.099	4.62	2
462	top	4.16	1.41	2639		3.95	3		1083	72	204	172	5.153	1.88	1
463	towel	4.23	1.72	3298			1		990	78		22	3.135		2
464	track	5.81	2.00	2943			3		957	28			0.000		3
465	tractor	5.70	2.21	2931			2		1216	80		11	2.485		2
466	trafficlight	5.92	2.06	3336		3.45	3		1021	62			0.000	4.55	2
467	train	4.33	1.64	2501		2.58	1		838	96	82	81	4.407	4.15	1
468	trashcan	4.58	1.72	2666		3.70	3		984	68		0	0.000	1.08	2
469	tree	3.49	1.54	2742	2.03		1	22.10	796	98	59	191	5.257	4.68	1
470	tripod	9.39	2.76	3230			3		1571	62		1	0.693		2
471	trophy	6.19	1.90	3066			3		1452	44		4	1.609		2
472	truck	3.77	1.36	2292		3.08	1		987	96	57	36	3.611	4.02	1
473	trumpet	6.61	2.06	3641		5.39	3	56.50	1053	68	7	8	2.197	2.60	2
474	trunk	5.89	2.07	3843			3		1233	58		48	3.892		1
475	turkey	4.28	1.11	2935			1		1160	92		5	1.792		2
476	turtle	4.24	1.43	2784	2.97		1		734	100	8	4	1.609	2.40	2
477	tweezers	7.37	2.69	2963			3		1328	82		2	1.099		2
478	typewriter	6.62	2.21	4240			3		778	100		11	2.485		3
479	umbrella	4.83	1.69	3103	4.09	3.80	3	23.40	738	100	8	14	2.708	3.95	3
480	unicorn	5.53	2.04	2580			3		928	100		1	0.693		3
481	unicycle	7.58	2.13	3096			3		1179	78			0.000		4
482	vacuum	5.23	1.77	2772			1		930	82		15	2.773		2
483	vase	6.07	1.94	2951			3		1171	90		7	2.079		1
484	vest	6.39	2.14	2634	4.30	4.87	3		919	96	4	7	2.079	2.78	1
485	violin	6.66	2.24	3323			3		1051	82		6	1.946		3
486	volcano	6.12	1.93	2783			3		1063	100		6	1.946		3
487	waffle	5.26	2.22	3062			3		1270	34		1	0.693		2
488	wagon	4.19	1.50	2267	3.03	3.18	3		1192	62	55	11	2.485	2.50	2
489	waiter	6.91	2.24	3365			3		1156	82		22	3.135		2
490	wall	4.12	1.46	3134			3		1050	38			0.000		1
491	wallet	5.77	1.72	3106			3		1382	68		8	2.197		2
492	walnut	5.90	1.91	3174			3		1282	58		5	1.792		2
493	walrus	6.04	1.92	2612			3		1006	80		1	0.693		2
494	wardrobe	8.83	2.36	3784			3		1078	86		11	2.485		2
495	ashingmachine	5.90	2.19	3181			2		1085	72		1	0.693		4
496	watch	4.83	1.57	2840		4.27	1	38.50	780	100	81	40	3.714	4.58	1
497	wateringcan	6.68	2.30	3741		4.74	3		1577	22		0	0.000	2.72	4
498	watermelon	4.52	1.44	2900		4.08	3		920	98	1	0	0.000	3.05	4
499	web	4.99	1.67	3070			3		869	68			0.000		3
500	well	5.69	1.83	3650			3		991	92		5	1.792		1
501	whale	4.82	1.90	1971			3		1050	94		11	2.485		1
502	wheat	6.61	1.97	3096			3		1428	42		29	3.401		1
503	wheel	4.28	1.47	2497		3.25	3	25.10	913	100	56	44	3.807	2.22	1
504	wheelbarrow	5.96	2.20	3035			3		1207	86		1	0.693		3
505	wheelchair	6.39	1.84	3412			3		881	98		3	1.386		2
506	whip	6.53	1.91	4949			3		1272	78		14	2.708		1
507	whistle	5.07	1.62	2814		4.68	3	50.50	790	98	4	9	2.303	2.45	2
508	wig	6.80	2.06	3322			3		933	94		13	2.639		1
509	windmill	6.43	2.10	4222			3		1226	84		9	2.303		2
510	window	4.02	1.39	2531			1		822	100		200	5.303		2
511	wineglass	7.60	2.47	3777	5.48		3		946	66	1	145	4.984	1.80	1
512	wing	4.90	1.41	3526			3		996	90		58	4.078		1

Pic #	Picture Name	M(AoA)	SD(AoA)	M-RTs (AoA)	C73AoA	S96AoA	CDI	mobjAoA	PN-targ RTs	%targ name	K-F ('67)	ELEX ('93)	Log-Freq	s80fam	o. of Syll.
513	witch	4.61	1.58	2408			3		879	100		32	3.497		1
514	wolf	5.20	1.84	2781			2		1262	56		10	2.398		1
515	woman	3.86	1.66	2649			3		1057	68		850	6.746		2
516	worm	4.10	1.38	3304			3		1110	94		17	2.890		1
517	wrench	7.16	2.46	2773			3		1331	84		3	1.386		1
518	yoyo	5.29	1.72	2309			3		1141	94		0	0.000		2
519	zebra	4.69	1.56	2475			2		864	98		2	1.099		2
520	zipper	4.64	1.44	2440			1		969	96		2	1.099		2

Table 2: Correlation coefficients of AoA ratings and rating times with CDI Index, Objective AoA (Morrison et al, 1997), IPN-RTs (target name), %target nameability, Frequency (& log frequency) [CELEX, 1993; Kučera-Francis, 1967], Familiarity ratings (Snodgrass, 1980)

	M-rating (AoA)	**CDI Index**	**Morrison Objective AoA**	**CELEX frequency**	**CELEX log frequency**	**Snodgrass Kučera-Francis frequency**	**Snodgrass familiarity ratings**
Mean Rating (AoA)	--	.63**** (N=520)	.69**** (N=127)	-.32**** (N=491)	-.41**** (N=520)	-.36**** (N=161)	-.47**** (N=174)
Mean RTs (AoA)	.43**** (N=520)	.29**** (N=520)	n.s. (N=127)	-.16** (N=491)	-.14* (N=520)	n.s. (N=161)	n.s. (N=174)

*p < 0.005 ** p < 0.001 *** p < 0.0001 **** p= .0000

Table 3: Correlation coefficients of AoA ratings and rating times, CDI Index, Objective AoA (Morrison et al, 1997), Frequency norms & Log Frequency (CELEX, 1993); Frequency norms (Kučera-Francis, 1967), Familiarity ratings (Snodgrass, 1980) with IPN-RTs (target name), IPN-% target nameability.

	Mean rating (AoA)	**Mean RTs (AoA)**	**CELEX frequency**	**CELEX log frequency**	**Snodgrass Kurera-Francis frequency**	**Snodgrass familiarity ratings**
Mean RTs to produce target name	.55**** (N=520)	.23**** (N=520)	-.19**** (N=491)	-.34**** (N=520)	-.27** (N=161)	-.39**** (N=174)
Percent of Subjects producing target name	-.36**** (N=520)	-.19**** (N=520)	n.s. (N=491)	.26**** (N=520)	n.s. (N=161)	n.s. (N=174)

*p < 0.005 ** p < 0.001 *** p < 0.0001 **** p= .0000

Table 4: Unique variance contributed by AoA ratings and rating times on the last step of Step-wise regression analysis (once the other variable is included in the model)

	Mean RTs to produce target name	**Percent of Subjects producing target name**
% Variance	30%	13%
M-AoA-rating	0.29****	- 0.097****
M-AoA-RTs	n.s.	n.s.

*p < 0.005 ** p < 0.001 *** p < 0.0001 **** p= .0000

Table 5: Unique variance contributed by AoA ratings and other lexical predictors (frequency, familiarity, CDI, syllable and character length).

	Mean RTs to produce target name	**Percent of Subjects producing target name**
% Variance	31%	14%
M-rating (AoA)	.104****	-.037****
Frequency (log)	-.016**	-.014*
CDI Index	n.s.	n.s.
Syll. length	n.s.	n.s.

*p < 0.005 ** p < 0.001 *** p < 0.0001 **** p= .0000

Appendix C: *Scatter plots*

Figure 1 (a)

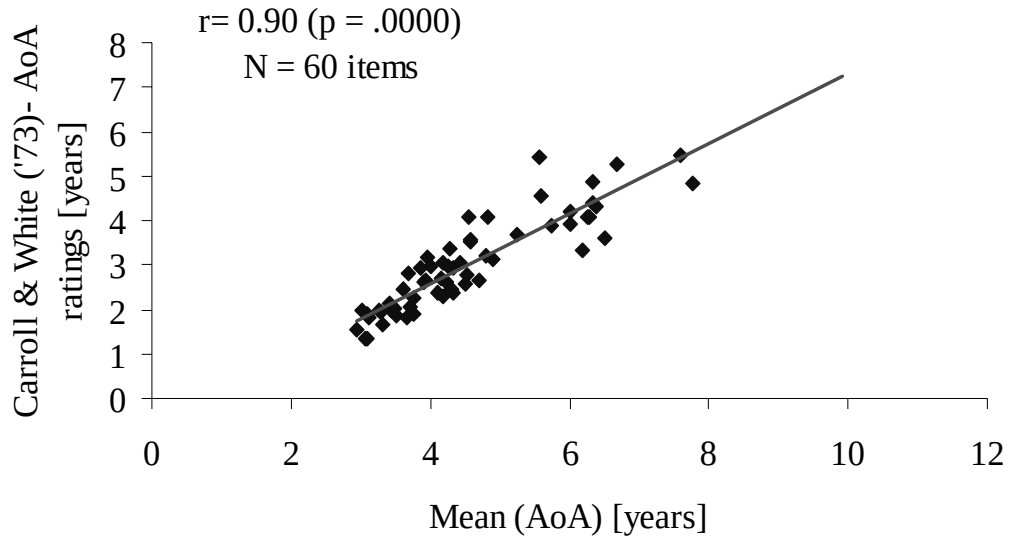

Figure 1 (b)

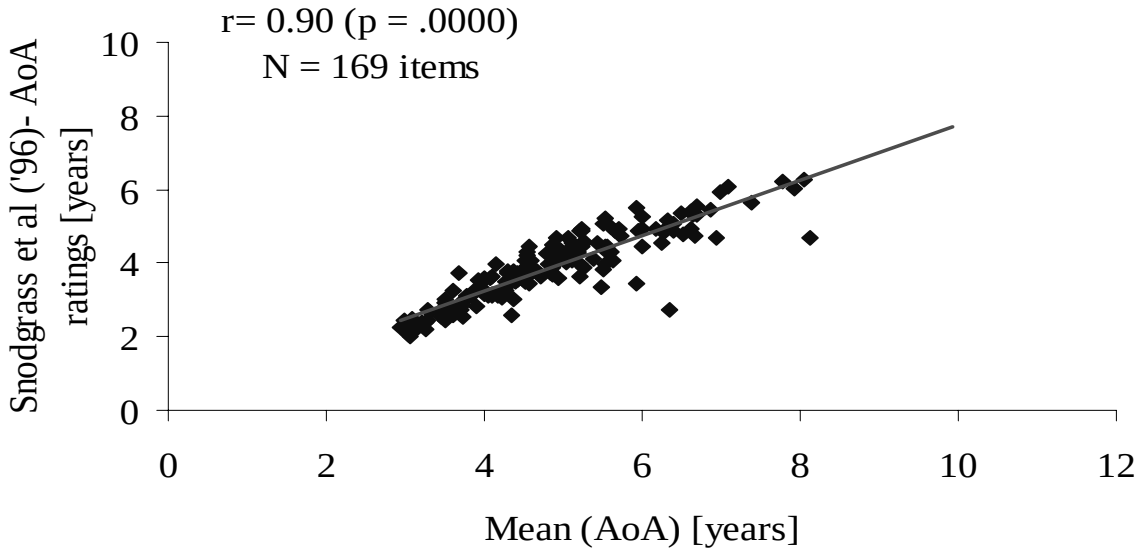

Figure 1 (a, b): Scatter plots of AoA ratings from (a) Carroll & White (1973) and (b) Snodgrass et al., (1996) plotted against the AoA ratings from the present study.

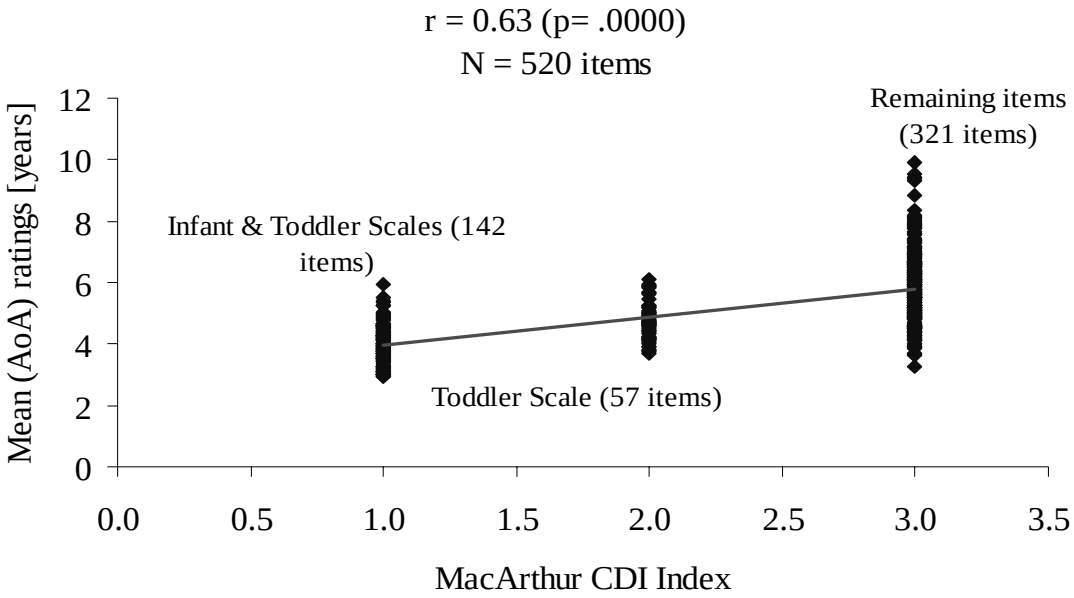

Figure 2: Scatter plot of the item-overlap from the Infant and Toddler scales in MacArthur CDIs, plotted against the mean AoA ratings obtained from Experiment 1.

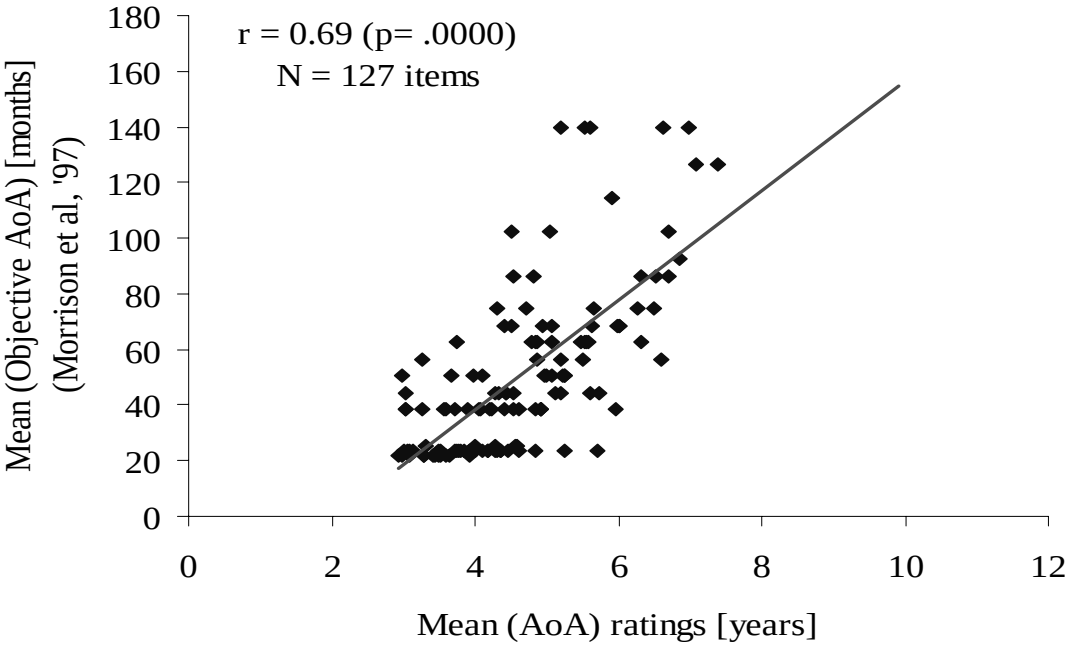

Figure 3: Scatter plot of the mean AoA ratings from Experiment 1 plotted against the mean objective AoA data (picture naming times from children) for all the items in common.

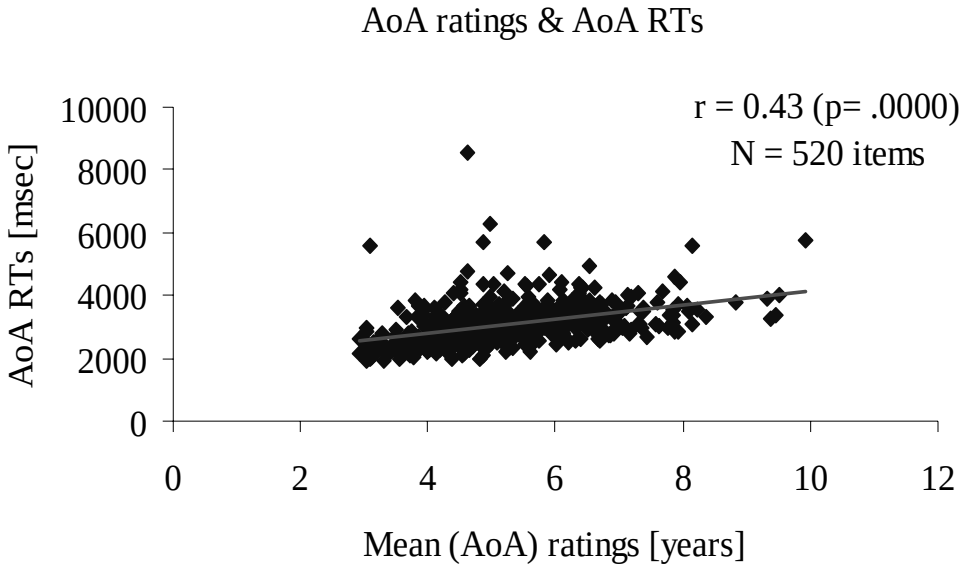

Figure 4: Scatter plot of the mean AoA RTs (msec) plotted against the mean AoA ratings, both collected from the present study.

Figure5 (a)

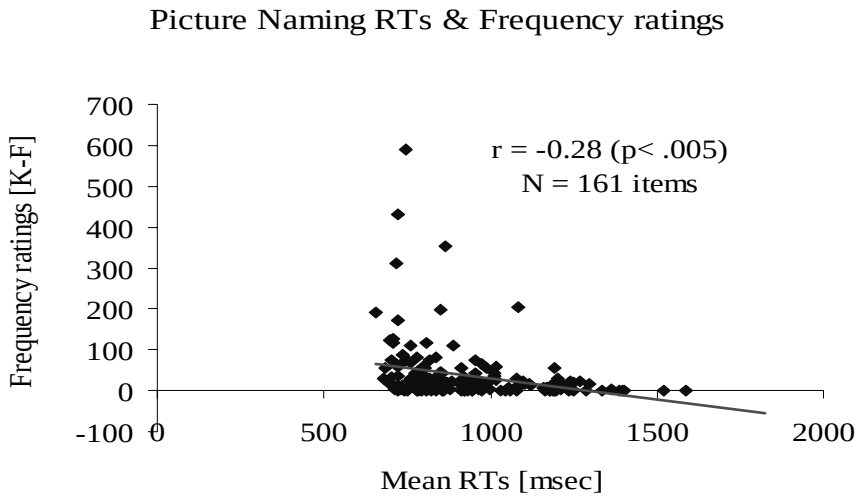

Figure 5(b)

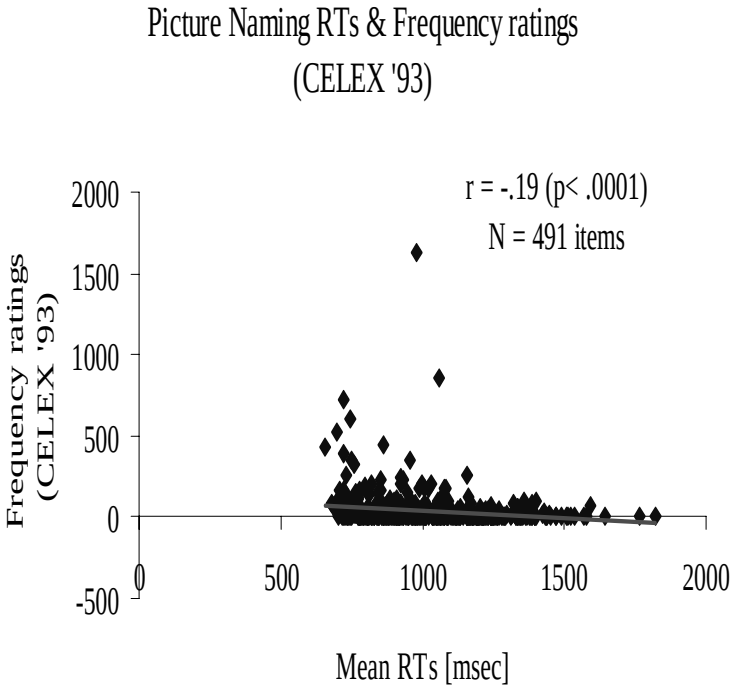

Figure 5 (c)

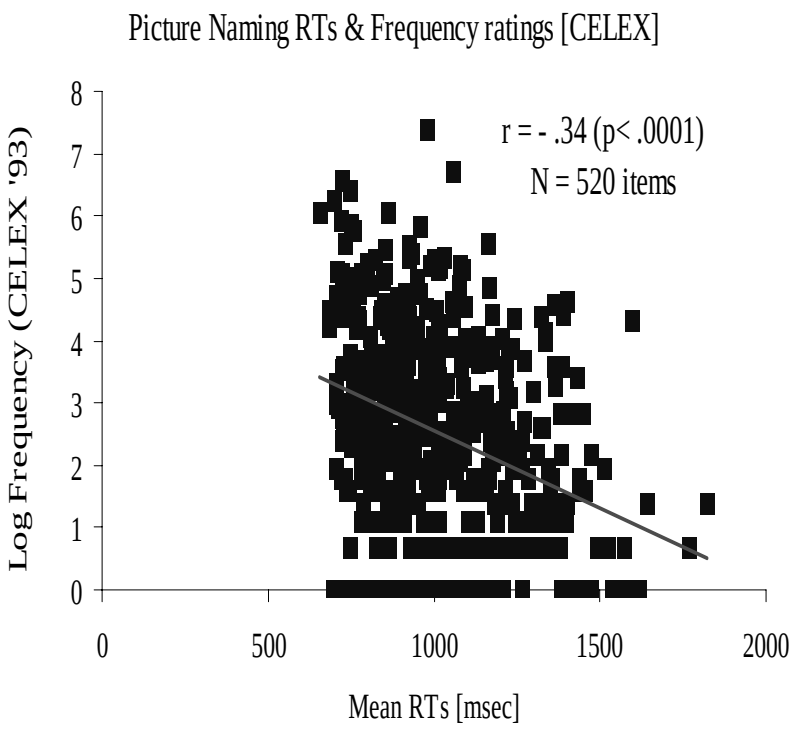

Figure 5 (a, b, c): Scatter plot of the picture naming RTs from IPN project, plotted against the word-frequency data from (a) Kučera-Francis (1967) and (b) CELEX database (1993) (c) log frequency (CELEX, '93) for all the items in common.

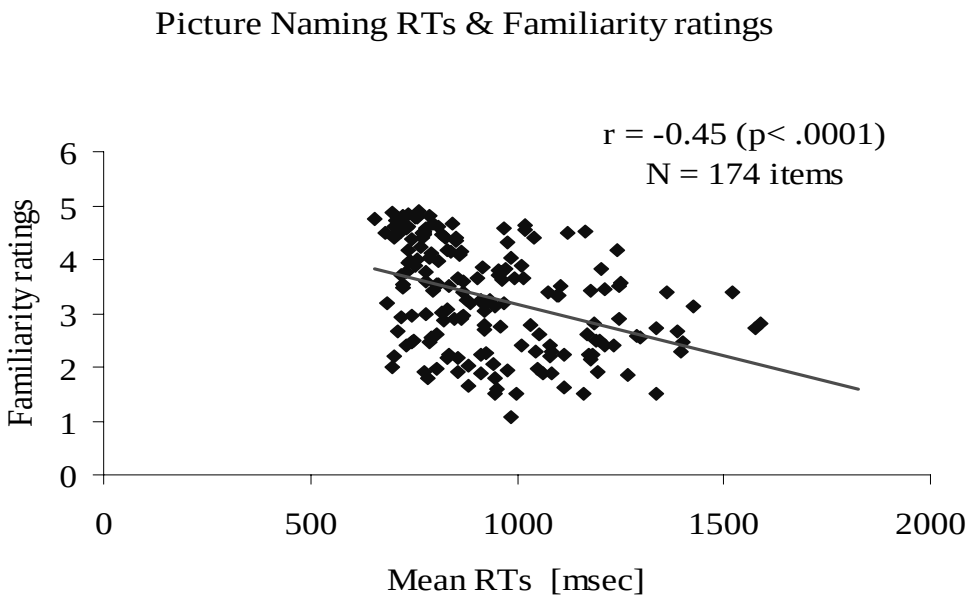

Figure 7: Scatter plot of the mean RTs from IPN project, plotted against the familiarity ratings (Snodgrass, 1980) for the 108 items in common.

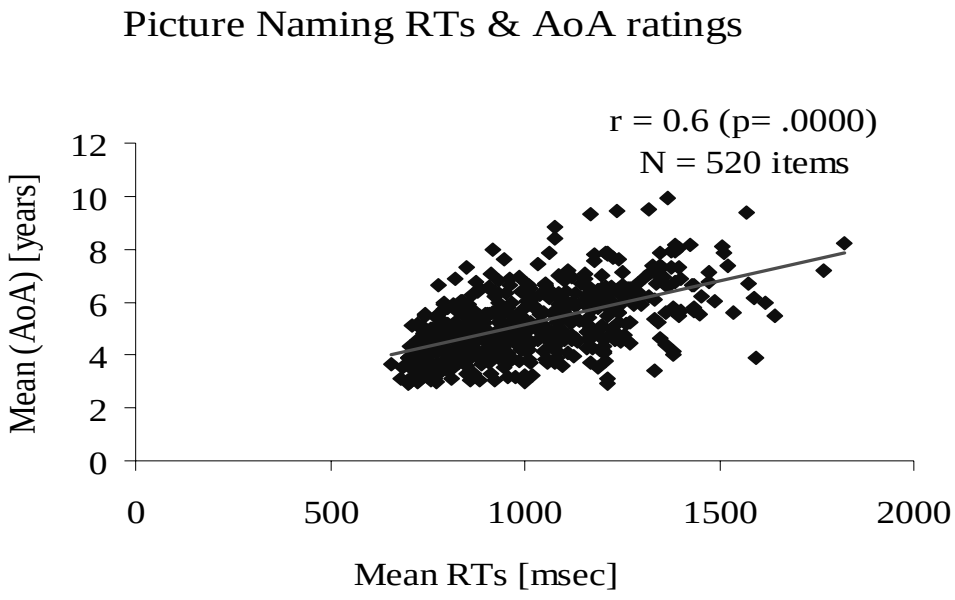

Figure 8: Scatter plot of the mean PN-RTs (from IPN project), plotted against the mean AoA ratings from present study, for all the 520 items.