The effects of age of acquisition in processing people's faces and names

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Viviene M. Moore

Submitted for the Degree of Doctor of Philosophy, University of Durham, 1998.

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ABSTRACT

Word frequency and age of acquisition (AoA) influence word and object recognition and naming. High frequency and early acquired items are processed faster than low frequency and/or late acquired items. The high correlation between word frequency and AoA make these effects difficult to distinguish. However, this difficulty can be avoided by investigating the effects of AoA in the domain of recognising and naming famous faces and names. Face processing a suitable domain because the functional models of face processing were developed by analogy to word and object processing models.

Nine experiments on the effects of AoA on face and name processing are reported. Experiment 1 investigated the influence of variables on naming famous faces. The variables were regressed on the speed and accuracy of face naming. Only familiarity and AoA significantly predicted successful naming. A factorial analysis and full replication revealed a consistent advantage for name production to early acquired celebrities' faces (Experiments 2 & 3). Furthermore this advantage was apparent from the first presentation (Experiment 4).

Faster face and name recognition occured for early acquired than late acquired celebrities (Experiments 5 & 8). Early acquired names were read aloud faster than late acquired names (Experiment 7). Conversly semantic classifications were made faster to *late* acquired celebrities' faces (Experiment 6), but there was no effect in the same task to written names (Experiment 9).

An effect of AoA for celebrities, whose names are acquired later in life than object names is problematic for the developmental account of AoA. Effects of AoA in recognition tasks are problematic for theorists who propose that speech output is *the* locus of AoA. A mechanism is proposed to account for the empirical findings. The data also presents a challenge for computer modelling to simulate the combined effects of AoA and cumulative frequency.

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DECLARATION

This thesis is the outcome of my own work; none of it is the results of collaboration. No part of this thesis has been submitted in candidature for any other degree or qualification. The copyright of this thesis rests with the author. No quotation from it should be published without her prior written consent and any information derived from it should be acknowledged.

Some of this work has been reported elsewhere. Experiment 1 was presented at the British Psychological Society Post Graduate Annual Conference, Cardiff in July 1995; to the Economic and Social Research Councils' Object and Face Processing workshop. Cardiff, August 1995.

Experiments 1, to 4 were presented to the British Psychological Society Cognitive Section Annual Conference, Keele (September 1996); and to the Experimental Psychological Society, London (January 1997). These experiments were also presented in a different format in a Departmental Research Weekend to the Dept. of Psychology, Goldsmiths College, University of London, Cumberland Lodge, Windsor (April 1997). The talks were entitled "Age of acquisition effects in the speed and accuracy of name famous faces."

Experiments 5 to 9 were presented in a talk entitled 'A proposed locus for age of acquisition effects in naming famous people' at the Department of Psychology, University of Liege, Belgium (October 1996); to the Fifth European Congress of Psychology, University of Dublin, Ireland (July 1997); to the British Psychological Society Conference, London (December 1997) and to the 'Science Now' Radio 4 programme, (broadcast 27 & 30.December 1997).

Experiments 1 to 4 are described in:

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CHAPTER 1: FUNCTIONAL MODELS OF WORD, OBJECT AND FACES.

1.1 Introduction

This thesis will examine the theoretical explanations of how words, objects and people's names are processed by the cognitive system. The issue of central interest is when and how one learns the names of people and whether this has an effect on cognitive processing in later life. Some weaknesses in current theories of word and object recognition and naming are identified. The effects of the age of acquiring word and object names in current studies are used to examine the role of the age in acquiring information. Face processing is a closely related, while different domain, that may be useful in clarifying the problems that have been identified in object and word processing studies. First it is necessary to examine the origins of current theories of lexical processing and the evolution of theories of word and object naming, face recognition and people naming.

Mill (1883) proposed that proper names are connotative, in that they denote an individual called by the name, but do not otherwise indicate or imply any attribute belonging to the individual (Mill, 1883). This began a tradition of philosophical debate on the status of proper names, and especially people's names. For example, a table is something one eats from, sits around, etc. a person is an individual that lives, breaths, eats, etc. The label 'table' refers to a category of objects but a person's name does not. For example, some people share the name 'John Smith', but this imparts no other information because people's names lack meaning (e.g. Frege, 1892; Kripke, 1980). Other philosophers argue that proper names are not completely without meaning but may be seen as a form of shorthand descriptions (e.g. Russell, 1905, and more recently Searle, 1969; 1971). This argument continues in modern linguistics, where an important distinction is that of 'type' versus 'token' (Jackendoff, 1983; Katz, 1972; Levelt, 1989).

Proper names, especially people's names are seen to have only a token reference (an individual) as opposed to a type that denotes a category. For example, an upturned barrel may be used to eat from although it will share few of the physical attributes normally associated with a table.

Herbert (1997) argued that the process of name giving and the actual name itself may be an integral feature of individual societies, because a given name reveals much about the societal system of address and reference, within which an individual becomes embedded as a member of the community. Herbert refers to the implicit role of people's names and their importance to the complexities of social relations, roles, and status within any particular society. The name given and the use, or mis-use can reveal much about the relative power relationships with a given society. The importance of name use is evident even in British society where the name that one may permissibly call another person reveals implicit social contingencies. For example, a porter may call the head of college 'Professor Smith', while the professor may call the porter by a first name. Also, it may be permissible for the professor to forget the porter's name, but the opposite is not acceptable.

In general conversation one often 'loses' a word, this may cause a moment's thought for the word to be recalled or substituted with another word, then the conversation continues. However, when one forgets a proper name, other names will not suffice and the loss is more noticeable, even embarrassing. The one class of proper names that are most susceptible to this difficulty is people's names. Forgetting a person's name is the most commonly, and spontaneously reported memory problem (Cohen, & Burke, 1993; Brédart, 1993). It would appear that a variety of difficulties occur, or co-occur when a person's name is not spontaneously generated. There may be a short delay when one is aware of the 'feeling of knowing' the name, this is referred to as a tip-of-the-tongue

(ToT) state and may pass if the name becomes available. During this time one may remember semantic information about the person, the initial letter or phoneme of the name may also be recalled. Semantic information and letters in the name may be employed in a conscious search for the name, although it often remains elusive (Burke, MacKay, Worthley, & Wade, 1991).

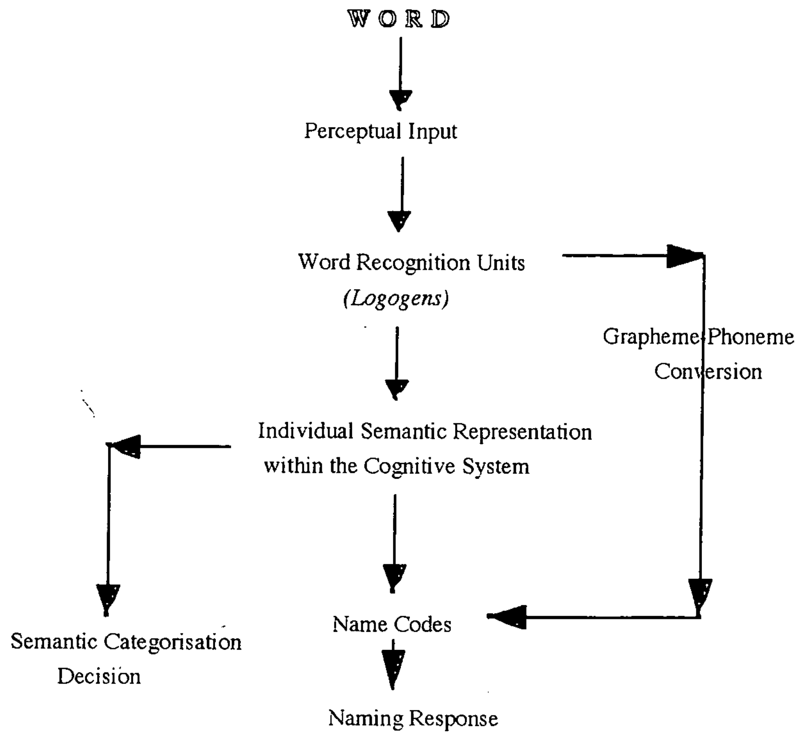
Current research on access to people's names has a pluralistic methodology, ranging from studies on name recognition, natural naming errors in every day life such as ToTs and laboratory studies of confrontation face naming where naming latencies are recorded. This research contributes to our understanding of the underlying mechanisms of cognition and combined with studies of pathological naming in anomic patients may help to elucidate some of the natural fracture lines in cognition.

1.2 The effects of word frequency on lexical processing.

Differences in word finding difficulties may appear to suggest that word processing and proper name processing are mediated in somewhat different ways. However, both are in fact words, using letter string combinations, subject to the same spelling rules, etc. It is perhaps not surprising that research into people's names developed from models designed to explain the processing of common object names.

Current theories of proper name processing evolved by analogy to functional models of object naming, which themselves developed from models of word recognition. Figure 1.1 shows a schematic representation of the 'Logogen Model' that was the first serious proposal used to investigate the kinds of processing mechanisms required for accessing words (Morton, 1969; 1979; 1980; Warren & Morton, 1982). At a basic level the mental lexicon was conceived of as a collection of units or *logogens*, each sensitive to its own specific information. There is one logogen (or *word recognition unit*) for each word in the mental lexicon. A logogen collects evidence that a particular word has occurred which causes activation within the unit. When activation exceeds some threshold value, the logogen fires and the phonological code is made available to the speech production system (Morton, 1969). The grapheme-phoneme conversion route is a direct route from word recognition to name codes that bypasses normal lexical processing. The grapheme-phoneme direct route is required to accommodate participants' ability to read and produce nonwords. The semantic and syntactic processing occurs in the cognitive system, which is largely unspecified in the model.

Figure 1.1: A schematic representation of the logogen model (Morton 1982).



The use of priming was important to the development of the logogen model. Priming refers to a facilitation in processing an item (such as a word, picture of an object, face, etc.) due to a recent encounter with the same item (as in repetition priming), and an associated or semantically related item (as in associative or semantic priming). Priming is a form of implicit memory that reflects the influence of past experience on current task performance. Therefore, it must depend upon some kind of memory representation resulting from a prior encounter. Repetition priming involves the same item. For example, in a face familiarity decision task participants are presented with celebrities' faces and unknown faces, the task is to decide whether or not each face is familiar. When the same face is shown on a subsequent presentation, decision times to primed items (items seen previously) are shorter than decision times to items that have not been previously seen or *unprimed* (Bruce & Valentine, 1985)

Semantic priming refers to the facilitation in processing an item when it has been preceded by a semantically related item. For example, presenting Prince Charles' face as the 'prime' before presenting Princess Diana's face as the test face would create a semantic priming facilitation. Deciding that Diana's face is familiar at test would be faster when it had been preceded by the face of Charles than if her face was preceded by an unrelated item (e.g. Tony Blair, the British Prime Minister) or an unknown face, e.g. *a neutral item* (Bruce & Valentine, 1986). This is because the units representing Charles and Diana share common links, whereas the others have no links in common. Repetition priming and semantic priming have different time courses. The time differences between primed and unprimed items for repetition priming are typically shorter than those found for semantic priming. Repetition priming however, is robust and long lasting whereas semantic priming has a very short duration and the priming effect is abolished by presentation of an intervening item (for lexical processing see Meyer & Schvaneveldt, 1971; for face processing see Bruce, 1986). The qualitative properties are also different, semantic priming can cross domain, e.g. presenting Prince Charles' face will prime a familiarity decision to Princess Diana's name (Young, Hellawell & De Haan, 1988). However, repetition priming is reported as modality specific for lexical processing, (e.g. Vanderwart, 1984) and face processing (e.g. Bruce & Valentine, 1985).

A primary assumption of the original logogen model was that producing a word by naming a picture or in response to a definition should prime identification of the printed word (Morton, 1969). However, the model was revised in the light of a study by Winnick and Daniel (1970). Winnick and Daniel found that naming the picture of a butterfly or generating the word "butterfly" to a description did not reduce the duration threshold required to identify the printed word "Butterfly".

A second assumption of the logogen model is that the system is concerned with visual recognition of pre-existing representations. For example, in lexical decision tasks participants respond as quickly as possible to indicate whether or not a letter string constitutes an English word. The involvement of the semantic system was proposed when it was established that participants took longer to reject pseudo-homophones, e.g. 'BRANE' compared to latencies to reject non-words, e.g. 'BLANE' (Rubenstein, Lewis, & Rubenstein, 1971; Coltheart, Davelaar, Jonasson & Besner, 1977). Laboratory studies have also shown effects of word frequency (common words being processed faster than rare words) when participants saw degraded images of the stimuli they had to name (e.g. Becker & Killian, 1977). Both tasks are sensitive to the effects of word. Morton (1969; 1970) placed the effects of frequency at the word recognition level. Each word is represented by its own logogen that fires when the level of activation reaches a threshold. Morton argued that successive encounters with a word would progressively lower its logogen's threshold, and so frequently encountered words would come to be recognised more rapidly than less frequently encountered words.

Word frequency is usually defined by the number of occurrences per million in written English. High frequency words tend to be short (as letter strings, the number of phonemes and syllables); highly imageable, concrete (denoting an object) and learned earlier in life than are low frequency word. Low frequency words have a tendency to be long, less easily imaged, more abstract and learned late in life. In psychological experiments word frequencies are usually derived from word frequency corpora (e.g. Thorndike & Lorge, 1944; Kucera & Francis, 1967; Hofland & Johansson, 1982; Johansson & Hofland, 1989). Thorndike and Lorge (1944) is a count of words in American written English, and comprises words derived from general samples of classical literature and magazines. The purpose for its inception was to guide teachers on when words should be learned. Kucera and Francis (1967) is a count of English words in American literature, including humour, scientific writings, etc. Johansson and Hofland (1989) employed the same technique of collection as Kucera and Fracis, but they report the use of written English in classical English literature

One problem with the use of any or all of the above measures of word frequency lies in the fact that the most data was collected over twenty years ago. Therefore some caution should be taken when translating its relevance to current everyday speech. For example, the word 'video' appears in each count as being of extremely low frequency (e.g. Thorndike & Lorge count is 2 per million). However, this word has been in almost daily usage over the past ten years. Other corpora have recorded counts of conversational language (e.g. Howes, 1966; Svartvik & Quirk, 1980; Brown, 1984) and may provide more ecologically valid measures of word use, however they contain fewer words than the older corpora. Although, it is possible that these high correlations are dependent on the word samples chosen.

Barry, Morrison and Ellis (1997) report high correlations for object names between two major written frequency corpora and frequencies of written and spoken language from the modern sample of the Celex database (Baayen, Piepenbrock, & van Rijn, 1993). The Celex database correlates with Kucera and Francis (1967) for written (r

= .78) and spoken words (r = .75) and with Hofland and Johansson (1982) for written (r = .81) and spoken words (r = .76).

Word frequency affects reaction time of lexical decisions to written words. Participants are faster to judge that high frequency words are English words than they are to judge that low frequency words are English words (e.g. Scarborough, Cortese & Scarborough, 1977). Participants read aloud high frequency words faster than they read low frequency words (e.g. Monsell, Doyle & Haggard 1989; Seidenberg, Waters & Barnes, 1984). However, the majority of studies reporting an effect of word frequency did not control for the age of acquiring the words.

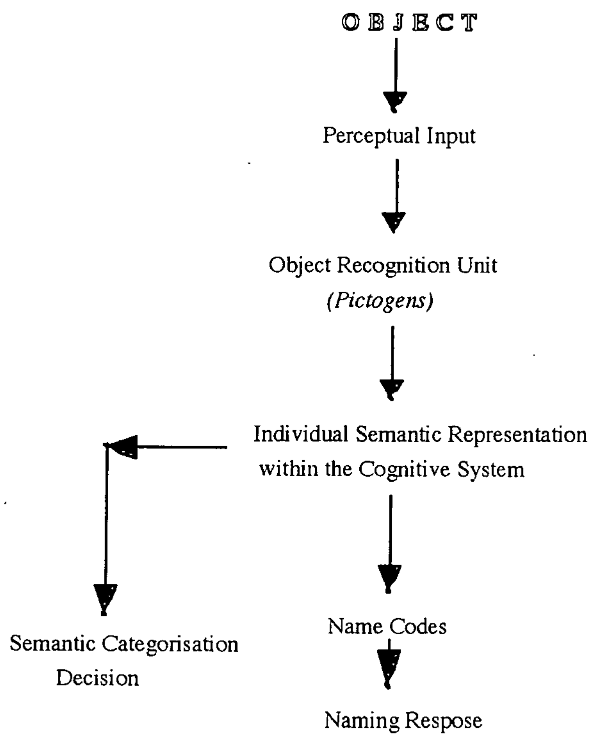
It has been shown that word frequency affects the time to read words aloud, make lexical decisions and recognise degraded words. However, none of the reported studies included the age of acquiring experimental items as an independent variable. It is important to note that these findings still drive the models of lexical processing especially computer simulations of lexical processing based on connectionist models. The mechanism most commonly proposed for these effects is that greater connection strength occurs between the levels of representations for frequently encountered items than exists for less frequently encountered items.

1.3 The effects of word frequency on picture naming.

Warren and Morton, (1982) incorporated the concept of pictogens in an object recognition model shown in Figure 1.2.

Pictogens (analogous to the logogens from the previous model) were envisaged as a visual analysis for matching previously stored pictorial information. There is one pictogen for each familiar object. The output from this process becomes an input to the semantic system. Items are then categorised and activation passes to the semantic system (to access knowledge about the items use). Finally, activation passes to the phonological output system for the picture's name to be produced. Models of both picture and word recognition require activation to pass through the system for articulation to occur. The major difference between the two models is the absence of a direct route from recognition to name codes (grapheme-phoneme conversion route in the logogen model) in the pictogen model. It was shown in the previous section that logogens have been presumed to be frequency sensitive and therefore word frequency should affect the recognition of both words and pictures. The word frequency of picture names was found to significantly correlate with children's picture naming speed (e.g. Miliani & Culliana, 1974).

Figure 1.2: A schematic representation of the pictogen model (Warren & Morton's 1982)



Oldfield and Wingfield (1964) were the first to report that the latency to name a picture of an object is a function of the frequency of the object's name in word frequency corpora. Thus, pictures of objects with high frequency names like 'chair' were named more quickly than objects with low frequency names such as 'metronome', (e.g. Oldfield & Wingfield, 1964; 1965; Humphreys, Riddoch & Quinlan, 1988; Jescheniak & Levelt, 1994).

From their studies in which participants were required to name line drawings, Oldfield and Wingfield (1964: 1965) proposed that an effect of word frequency could be explained by two stages of processing. In the first stage a picture is recognised and its meaning attributed to a particular frequency range. Second, a random binary search of words in that frequency range is made for the appropriate word's selection. It is important to note however, that these interpretations were based on data derived from small numbers of participants and stimuli (e.g. twelve participants and twenty-six stimuli).

It has been shown that word frequency affects the time to name pictures of objects. According to the model of object recognition an object undergoes perceptual analysis to generate the internal representation of its visual properties. A familiar object will activate the appropriate recognition unit. Activation then spreads from the recognition unit to access semantic information about the object (e.g. knowledge of its use). Only after semantic information has been accessed can activation pass to the name retrieval stage, it is here that the appropriate phonology becomes available to the articulatory system. Humphreys, Lamote and Lloyd-Jones (1995) implemented this hierarchy using an interactive processing architecture and located the resulting effect of word frequency on the weight of connections between the semantic system and name codes. As with the reported word frequency effects in lexical processing, the age of acquiring an object name was not controlled in these experiments.

1.4 The effects of age of acquisition on lexical processing.

When naming pictures of objects, making lexical decisions to written words and when reading words aloud, the processing or production of high frequency words is faster than for low frequency words. Indeed the effects of word frequency seem to be ubiquitous. However, renewed research interest in early studies has demonstrated that the age at which a word was first acquired is a powerful determinant of processing speed (e.g. Morrison, Ellis and Quinlan, (1992). This finding has created a controversy over whether word frequency or age of acquisition (AoA) is *the* important processing determinant. This issue arises because there is a high correlation between word frequency and AoA (e.g. in the range of r = -.59 to r = -.83, Carroll & White, 1973a; 1973b). Therefore, it is possible that the effects attributed to word frequency in the literature, should in fact, be attributed to, at least in part, the age of acquiring information. It should be noted that many word frequency studies failed to include measures of AoA.

Age of acquisition refers to the age at which one first learns a word. Measures of objective data are taken from sources of children's reading material (e.g. Rinsland, 1945). Measures of subjective data are collected from participant's ratings of items for the age at which they believe they first learned a word. High correlations have been reported between objective and subjective measures of AoA (correlation coefficients between r = .85 and .96). This indicates that the measures are reliable and valid also that rated AoA reflects a definitive learning age. Such measures have been reported to correlate in tests on children's learning age (e.g. Carroll & White, 1973a; Gilhooly & Logie, 1980a; Morrison, 1993). Carroll and White (1973a) report a strong correlation between subjective and objective measures of AoA (r = .85). Gilhooly and Logie (1980a) recorded various attributes for 387 words including AoA and report that the split half correlation coefficient of AoA ratings proved to be significant (from r = .93 to r = .96). Furthermore, they report the same effect in their following study (r = .98) on 1,944 words (Gilhooly & Logie, 1980b).

Recently, Morrison, Chapell and Ellis, (1997) have reported objective data collected from 285 children who named 297 pictures. Picture names were classified as belonging to a particular AoA vocabulary band when 75% or more of the children (in that age group) could name the picture correctly. Twenty adults provided subjective measures by rating the same picture-names. Morrison, *et al.* report a significant correlation (r = .76) between the adult ratings and children's naming ability.

Further evidence of the validity of AoA measures was reported with AoA ratings collected from two experimental studies. Children and adults were asked to estimate the age at which a word had been learned (Walley & Metsala, 1990; 1992). The correlations between young (5 years old) and older children (8 years old); between young children and adults and between older children and adults were all significant (evincing correlation coefficients of above .9).

Rubin (1980) collected measures of 51 properties for 125 words. The independent variables included seven measures of word frequency and one measure of AoA. In the word naming study, naming latency significantly correlated with AoA (r = .63) and with the various measures of word frequency (between r = .45 to r = .63). The regression analyses did not support the high correlation of word naming speed with AoA. There are good reasons why one would not expect AoA to significantly enter this regression model, especially as the highest correlation between one measure of 'word frequency' (taken from Rinsland, 1945) and naming speed (r = .63) was also a measure of children's' written AoA in other studies (cf. Carroll & White, 1973a). It is quite likely then that this measure of 'word frequency' is confounded with AoA. Further problems with the measures employed in Rubin's study and the intercorrelations between independent variables will be discussed more fully in Chapter 2, for the present it is noted that there are problems with the regression model, by introducing supressor variables into the model (see pages 77 and 78).

Butler and Haines (1979) included AoA and word frequency in their lexical decision study. They found correlations with decision latency for AoA (r = .33), word frequency (r = -.32) and word length (r = .28). However, this study used different groups of participants (with high and low vocabulary abilities). It is possible that the these groups employed different strategies that could be reflected in the results. The significant intercorrelation between AoA and the other independent variables (word frequency, r = -.55; word length, r = .58 and the multiplicative term of AoA x vocabulary, r = .92) could have de-stabilised the regression model.

The effects of AoA occur in lexical processing tasks. Morrison and Ellis (1995) reported that AoA, but not written word frequency, affected the speed of word naming and that both spoken word frequency and AoA exerted independent effects in a lexical decision task. Gilhooly and Logie (1981: 1982) found no evidence of an effect of AoA on visual or auditory word recognition thresholds. This suggested that the observed effects of AoA in naming and lexical decision must result from processes operating after lexical access. In contrast Turner, Valentine and Ellis (in press) found that both AoA and word frequency affected visual lexical decisions, but AoA alone affected auditory lexical decisions. The apparent conflict between these results may reflect the use of advanced computer technology by Turner *et al.* that allowed for precise measurement and control of auditory stimuli. Obviously such precise technology was unavailable at the time of the earlier studies.

Gerhand and Barry (in press) report significant effects of AoA in visual lexical decision tasks, where even the use of orthographically illegal non-words and pseudohomophones as non-words failed to remove the effect of AoA. The use of articulatory suppression as a secondary task (repetition of a nursery rhyme or repetition of a single word "the") while making lexical decisions also failed to extinguish the significant effect of AoA, which would be predicted if a single locus for the effects of AoA were at the phonological output lexicon.

Gilhooly and Logie (1981) investigated the effect of word frequency, concreteness, familiarity, imagery and AoA on the time taken to name words. The results of the multiple regression analysis showed a strong correlation between AoA and naming speed. The importance of these findings was replicated in a study that also included a measure of rated spoken word frequency to the same effect (Brown & Watson, 1987). Brown and Watson's data also showed that AoA was a major predictor of rated familiarity.

The significant correlations of AoA with word frequency may make the interpretation of results from multiple regression analyses problematic. However, the high correlations between different measures of AoA suggest that these measures are reliable and valid indicators of when a word was first learned. Age of acquisition clearly affected processing speeds when it was included as a measure in lexical processing tasks.

1.5 The effects of age of acquisition on picture naming.

Age of acquisition has also emerged as an important determinant of processing speed in picture naming. It has been proposed that the speed of object naming is a function of the age at which the object name was acquired. The earlier a name is acquired, the quicker it can be produced on confrontation with a picture of the relevant object (e.g. Carroll & White, 1973a).

Oldfield and Wingfield (1964) analysed data from twelve participants and twenty-six stimuli when they reported an effect of word frequency on object naming latencies. Carroll and White (1973a) performed a larger study and found that AoA was the major predictor of object naming speed. Carroll and White re-analysed a portion of their data (corresponding to the Oldfield and Wingfield stimulus sets) and concluded that AoA was the main predictor of naming speed. Word frequency alone did not account for a significant proportion of the variance. Carroll and White proposed word frequency measures only predict naming latencies to the extent that they reflect AoA. Furthermore, this may also be reflected in subjective judgements of frequency and familiarity.

Carroll and White (1973b) replicated their earlier picture naming study including various measures of word frequency, a subjective measure of AoA and word length as the independent variables in multiple regression analyses. Once again they concluded that the age at which object names were acquired was the chief determinant of naming latency, and that some measures of word frequency only predict naming latency to the extent that they reflect AoA. An advantage for early acquired items in picture naming tasks has also been reported by Lachman, Shaffer and Hennrikus (1974).

In a picture naming study Lachman (1973) found significant effects of word frequency, word codability (the number of responses to each item that elicited the same name response) and AoA in the multiple regression analyses. The effects of codability and AoA were also found in a larger study with children (from 4 years to 10 years of age) and with younger and older adult participants (Butterfield & Butterfield, 1977). Butterfield and Butterfield included AoA and item codability as independent variables with familiarity, concreteness, meaningfulness, a measure of letter order and imageability in their picture naming study. Age of acquisition and item codability had the highest simple correlation with the log transformation of the reaction time data. In multiple regression analyses both AoA and codability significantly predicted over 40% of the variance in naming speed, no other variables reached significance. However, as will be shown later, interpretation of both simultaneous and multiple regression analyses must be viewed with caution.

Gilhooly and Gilhooly (1979) drew a distinction between lexical and episodic memory, with regard to the effects of AoA. They found a facilitation in naming speed for early acquired picture names and for the production of words in response to bigram cues. However, in episodic tasks of recall and recognition significant effects of serial position, imagery and frequency were demonstrated, but not of AoA. Once again however, there is evidence that highly intercorrelated independent variables de-stabilised the regression models (see pages 77 and 78).

An effect of AoA was found in a study on children's picture naming speed where two measures of AoA were recorded (Done & Miles, 1988). The measure was based on empirical object naming data (the calculated age at which 75% of children were able to correctly name a picture). Sixteen unimpaired children and 16 dyslexic children named pictures as quickly as possible. The correlation with naming speed was higher for AoA than for word frequency in both the participant groups. The regression analyses revealed that the proportion of variance accounted for by word frequency was not significant when AoA was partialled out of the model, but that AoA remained a significant factor when frequency was removed.

Morrison *et al.* (1992) re-analysed Oldfield and Wingfield's (1965) data and included rated AoA in multiple regression analyses. These analyses revealed that AoA was the major determinant of naming speed and that word frequency played no independent role when its correlation with AoA was taken into account. Morrison *et al.* (1992) replicated this result in a study of object naming. They also showed that there was no effect of AoA on the time taken to make semantic decisions to objects (deciding whether the objects depicted in line drawings were natural or man-made).

This brief review of the literature shows that there is an unambiguous effect of AoA in a number of tasks involving word recognition and word and object naming. In the next section the relationship between the effects of word frequency and AoA is considered.

1.6 The relationship between word frequency and age of acquisition.

Carroll and White (1973b) and Morrison *et al.* (1992) argue that there is no independent effect of word frequency on object naming latency and that word frequency only has an effect to the extent of its intercorrelation with AoA. However, other studies have found independent effects of word frequency and AoA for some picture naming and word processing tasks. Lachman (1973) reported significant effects of subjective ratings of word frequency, word codability (or name agreement) and AoA. Butterfield and Butterfield's (1977) picture naming study on children and adults support these findings. Lachman *et al.* (1974) report significant independent effects of both AoA and subjective ratings of spoken word frequency in picture naming. Barry *et al.* (1997) report a picture naming study in which the Snodgrass and Vanderwart (1980) picture set was used to collect naming latency data. Analysis using multiple regression revealed a significant multiplicative term (spoken word frequency x AoA). The interaction was such that there was no difference in naming speed between early acquired and late acquired pictures with high frequency names, but pictures with early acquired, low frequency names were named faster than pictures with late acquired, low frequency names.

When evaluating the effects of word frequency and AoA consideration needs to be given to the different measures used. For example the written word frequencies from Rinsland (1945) were employed both as measures of word frequency (e.g. Rubin, 1980) and objective measures of AoA (e.g. Carroll & White 1973a). Consideration is also necessary for the choice of statistical analysis employed. For example, most of the AoA studies cited above relied upon multiple regression analyses and all report high intercorrelations between many independent variables. Serious doubts have been expressed concerning the 'mis-use' of multiple regression analysis in cognitive psychology (e.g. Lorch & Myers, 1990; Morris, 1981). Some of the problems associated with multiple regression analyses in cognitive research will be discussed in Chapter 2. However, despite these problems it can be concluded that clear effects of AoA have been found in lexical decisions (Gerhand & Barry, in press) and picture naming (Barry, Johnston, Hirsh & Williams, submitted). Furthermore, Barry *et al.* (submitted) report a picture naming study in which AoA and word frequency were manipulated in a factorial design, thereby avoiding some the problems of interpretation posed by multiple regression analyses. They report a clear effect of AoA and <u>no</u> effect of word frequency.

Word frequency and AoA both affect the speed of lexical decision tasks (Morrison & Ellis, 1995; Gerhand & Barry, in press). Gerhand and Barry found that the interaction was such that the effect of AoA was larger for low frequency words than for high frequency words. The interaction remained in experiments that manipulated the nature of the non-words and added articulatory suppression as a secondary task. Gerhand and Barry (1998) found additive effects of both AoA and word frequency on oral word naming latency, this suggested that there may be separable loci for these effects.

The empirical data on the relationship between AoA and word frequency reveal a complicated picture in which the relationship may be task-dependant and the results often contradictory. The most recent work has made use of factorial designs to give more reliable results for interpretation than earlier studies based on multiple regression and partial factorial designs. It is clear that the results from any of the cited studies may depend on the measures of word frequency and AoA employed as well as the methods of statistical analyses. Although the high intercorrelation between AoA and word frequency makes the nature of the relationship difficult to disentangle. There is however, an unambiguous effect of AoA as was evident when AoA remained at a significant level even when word frequency was removed from the regression model.

Models of human cognition, (e.g. connectionist models) have been designed to account for the effects of word frequency. However few, if any, can fully account for the effects of AoA. For example, Seidenberg and McClelland's (1989) model, which uses backward error-propagation to learn mappings between orthography and phonology, has been shown to account for a wide range of effects in normal reading, simulating effects of word frequency on word naming latency. In these (parallel distributed processing, or PDP) models the word forms are captured in a matrix of connectivity among hundreds or thousand of units (e.g. McClelland & Rumelhart, 1985; Rumelhart, McClelland & the PDP research group, 1986: Seidenberg & McClelland, 1989). An individual pattern of connectivity represents the activation of the input of a word's attribute. Part of the pattern may be shared by many other words, but each whole pattern remains unique to a specific word or name. These models operate at a distributed level of representation, depending upon the accurate activation of a particular combination of units at any given level. In this way different items may share units in common but each will have a unique pattern of activation for each representation. Repeated co-activation of a pair of units by a corresponding pair of stimulus elements in the input strengthens the connections between them, whereas activation of one unit alone weakens this connection. The models learn by one of two methods, either by the modification of the weights of auto-associative links among the units within the input domain (e.g. McClelland & Rumelhart, 1985). The second method of learning is modifying the weights of connections from input units to a layer of "hidden units", which mediate between input and output units, (e.g. Seidenberg & McClelland, 1989). The pattern of learning in these models is viewed as intrinsically frequency sensitive, that is as a function of the 'experienced' frequency of occurrence of co-occurring pattern elements.

It has been shown that different researchers have interpreted a single measure (e.g. taken from Rinsland, 1945) to be one of word frequency (Rubin, 1980) and an objective measure of AoA (Carroll & White, 1973a). It has also been shown that different measures of an attribute are often included in the same regression models. Extremely high intercorrelation statistics between independent variables are reported in most, if not all regression studies. For example, Barry *et al.* (1997) report highly significant intercorrelation coefficients between log spoken word frequency and log written word frequency (r = .894). Some studies report a multiplicative term; other studies partial independent variables out of the regression model; while other studies report interactions from the regression analysis. The different methods of measurements and statistical manipulations do not allow for valid comparisons to be made across different studies and make interpretation of the various results very complicated.

1.7 Mechanisms for the effects of word frequency.

Morton (1969) proposed that the effects of word frequency reflect a progressive lowering of the logogen's threshold by successive encounters with a word. This allows frequently encountered words to be recognised more rapidly than less frequently encountered words.

Early reports of the effects of word frequency revealed faster naming latencies for pictures of objects with high frequency names like 'chair' than items that with low frequency names such as 'metronome' (Oldfield & Wingfield, 1964; 1965; Humphreys *et al.*, 1988; Jescheniak & Levelt, 1994). Humphreys *et al.* (1995) have simulated the effect of word frequency on picture naming using an interactive activation and competition architecture and attribute these effects to stronger connection strength of links between representations. In contrast Jescheniak and Levelt (1994) interpret the effect of word frequency in picture naming as a property of the lexeme (the representation of the phonological word-form) rather than to connection strength of links between representations.

The Morton model of lexical processing proposes different mechanisms for the effects of word frequency. One mechanism suggests the connection strengths between more distributed representations are determined by frequency of exposure (e.g. Humphreys *et al.*, 1995). An alternatively possibility is that frequent exposure causes the threshold of activation to be lowered in the word recognition unit (Morton, 1969).

1.8 Mechanisms for the effects of age of acquisition.

Some explanations for the effects of AoA appear to be remarkably similar to explanations of word frequency. For example, it has been suggested that logogens corresponding to early acquired words would have lower thresholds than the logogens for later acquired words, and therefore would require less activation for the logogen to fire (Gilhooly & Gilhooly, 1979). However, Gilhooly and Gilhooly argue that because early acquired words are probably used to learn later acquired words, the early words would receive frequent implicit activation when the late acquired words are used.

Following the analysis of Oldfield and Wingfield's data, Morrison *et al.* (1992) replicated the significant effects of AoA on object naming latencies. However, they also established that AoA did not affect the speed of semantic decisions made to objects (deciding whether pictures depicted objects that were natural or man-made). Morrison *et al.* concluded that the locus of AoA is at the stage of the phonological output lexicon. This conclusion is consistent with the locus of AoA proposed by Brown and Watson (1987), who suggested that the effect of AoA reflected a developmental stage in language acquisition. They proposed that early acquired words have more *complete* representations in memory than later acquired words, and therefore early acquired words are produced more rapidly throughout later life. For example, early acquired words form a basic word representation, whereas the later acquired word endings are represented in a more abstract form and require assembling before word production can take place.

A consensus for a primary locus at the name retrieval stage may appear problematic for the reported effects of AoA in lexical decision tasks, because no spoken response is required. However, these effects have been attributed to automatic activation of phonology from visual word recognition (Morrison & Ellis, 1995; Gerhand & Barry, in press).

Few researchers investigating the effects of AoA distinguish between the separate stages in lexical retrieval, attributing the locus of AoA to the speech output lexicon (e.g. Morrison *et. al.* 1992). However, the model of lexicalization proposed by Levelt (1989) assumed that lexical access comprised two major processing stages prior to articulation. The first stage employs conceptual, semantic and syntactic information for *lemma* selection (an abstract representation of the word in the *semantic lexicon*). Lemma selection activates the second stage of *lexeme* activation. A lexeme is the phonological representation of the word (in the separate *phonological lexicon*). Once activated the lexeme makes the phonological code available that is passed to the speech production system for articulation. This model allows three possible loci of AoA in the lexicalization process: selection of the lemma, the links between lemma and lexemes, or the selection of the lexeme. In a repetition priming study Barry *et al.* (submitted) report an interaction between the effects of word frequency and AoA and concluded that the locus of AoA is in the lexeme. Jescheniak and Levelt (1994) concluded that the locus for the effect of word frequency on speech production is at the lexeme. However, as Jescheniak and Levelt did not control for AoA it is entirely possible that the reported effect of word frequency is really an effect of AoA, in which case their conclusion is consistent with Barry *et al.* (submitted).

There are some data that is not compatible with a *single* locus at phonological representations for the effects of AoA. Yamazaki, Ellis, Morrison and Lambon Ralph (1997) demonstrated that the speed of reading Japanese Kanji characters showed effects of both the age at which words entered the *spoken* vocabulary and the age at which Japanese children learn the characters used to *write* the words. Yamazaki *et al.* argue that these effects suggest AoA affects the quality of lexical representations in both the visual input lexicon and the speech output lexicon, requiring at least two loci of AoA. However, Yamazaki *et al.'s* interpretation of 'independent' effects of AoA for both written and spoken words may be questionable because of the inclusion of these highly correlated variables in the same multiple regression analysis.

Clearly the empirical effects for some word and object processes are influenced by either a combination or independent effects of AoA and/or word frequency. It is also apparent that the mechanisms and loci proposed for both are very similar, if not in some cases, interchangeable. Theories of AoA will become more distinct in the following section where it will be shown how theories of language development can incorporate the effects of AoA.

1.8.i The completeness hypothesis.

Brown and Watson (1987) proposed that AoA reflected a word's consolidation in memory in that early acquired words would have a more *complete* phonological representation than words acquired later in life. In the completeness hypothesis Brown and Watson (1987) argued that early acquired words have more *complete* representations in memory than later acquired words, and therefore early acquired words are produced more rapidly throughout later life. Furthermore, Brown and Watson (1987), suggested that the effect of AoA reflected a developmental stage in language acquisition, leading to functionally different storage mechanisms for early and late acquired words, with only minimal information about late acquired words being stored explicitly. Thus, phonological assembly would take less time for early acquired than for late acquired words. This mechanism for an effect of AoA is entirely consistent with the conclusion that phonological representations are the primary locus of AoA effects.

1.8.ii Cumulative frequency and residence time in memory.

It could be argued that the effects attributed to AoA reflect the length of time a word has actually resided in memory. If a word had been learned early in life, it has been there longer and thus would have been retrieved, or activated, more often than late acquired words. Carroll and White (1973a) suggested that the effects of AoA could reflect cumulative frequency of encountering a word over a complete life span. They measured this by a multiplicative function of the time a word had been known and its frequency of occurrence. They used a measure of a word's frequency multiplied by the number of years the word had resided in memory. However, they did not find that the inclusion of this function significantly improved the account of their data

Gilhooly and Gilhooly (1979) investigated the role of cumulative life frequency in a word completion task. They used a multiplicative term (root word frequency x [8 - rated AoA]) for each word to give a life span frequency (ratings for AoA were made on a scale of 1 = early acquired to 7 = late acquired). The simple correlation of life span frequency and the hit rate was significant (r = .30), but when the multiplicative term was partialled out of the model, the correlation fell below significance (r = -.09). Gilhooly and Gilhooly interpreted this result as demonstrating that AoA and word frequency have non interactive effects. The nature of non interacting effects suggest that AoA and word frequency have different loci. They proposed that word frequency was a component of episodic memory, but that AoA was located within the lexical memory.

Gilhooly (1984) investigated residence time in memory by using words that had relatively recently entered the general vocabulary, (e.g. skateboard and hatchback, etc.) in groups of young (early acquired) and older (late acquired) participants. Word residence time was estimated as the participants' age minus the rated AoA measure. The task was to name each word as quickly as possible. The results showed that AoA held the most predictive power of all variables. Gilhooly concluded that AoA had a significant independent effect on word naming but that residence time in memory did not. However, even the most cursory glance at the 42 stimulus items for 'long established words' reveal these to be of low frequency, e.g. 'accuser' and 'ether'. Furthermore, most of the 26 items from the latest acquisition group (1977) comprised compound words such as 'backpack', 'skateboard', 'ongoing', etc. Gilhooly failed to include word frequency or the rated AoA of the individual segments of the compound words, therefore the interpretations derived from his regression model may have been spurious.

Gilhooly and Gilhooly (1979) argued that early acquired words are probably used to learn later acquired words, therefore early words receive frequent implicit activation whenever the late acquired words are used. This account is somewhat different from the account proposed by Morrison and Ellis (1995) and Morrison *et al.* (in press) who argue that accessibility of words is determined at the time of acquisition and remains 'more or less unchanged' over time.

Morrison *et al.* (in press) investigated cumulative frequency and residence time in memory in three experiments with young and older adult participants. Their hypothesis was that both cumulative frequency and residence time in memory would predict diminishing effects of AoA with age. There should be no diminution with age if the word accessibility was fixed at the time the word was learned. Therefore, they predicted the effects of AoA would be the same for both young and older groups. Morrison *et al.* (in press) report no effect of participants' age in two experiments on word naming. However, there was an interesting non significant trend for early acquired words to be read faster by young participants than by older participants, and for late acquired words to be read slower by young participants than by older participants. The same trend occurred when word frequency rather than AoA was manipulated. In the latter case the interaction was close to significance ($p<.07$). The measures of AoA were taken from normative data on children's naming rather than on adult estimates of AoA (Morrison *et al.*, 1997) and from a children's vocabulary database. There were three groups of participants, the young (between 18 and 32 years); middle (between 60 and 69 years) and older (over 80 years old). The results showed that naming speeds were progressively slower as age increased, however, all groups showed an effect of AoA. The over 80 group of participants were reported to have made a large proportion of 'errors' (e.g. 'cheese' to the picture of a *cake*; 'keg' to the picture of a *barrel* and 'fiddle' to the picture of a violin). It is possible to interpret some such errors in terms of AoA, because both keg and fiddle would have been in common usage as names for such items when these older participants were young. Older people may have more alternative names available to them than are available for younger people, which may have been reflected in higher error scores or verbal hesitations for this age group. This study highlights the importance of collecting separate AoA ratings from the people participating in the experimental tasks.

In summary, researchers have investigated the possibility that the effects of AoA could be due to the amount of time a word has resided in memory. Different measures of multiplicative terms are reported, none of which supplanted the significant effects of AoA, despite the fact that each multiplicative term included rated AoA in the calculation.

1.8.iii The acquisition of language.

It has been proposed that the age of acquiring a word is a fixed property and occurs during the language developmental period. If this is the case, then evidence should be available from the developmental literature. The current developmental view of language specificity proposes that infants are innately equipped to process tone, stress, vowel length, and other attributes, of any of the world's languages. Furthermore, infants become attuned to the phonemic contrasts in their linguistic environment during the first twelve months of life (Werker, 1994). Once they have established the relevant speech features, infants use these representations to discover the regularities in speech. For example, by nine months of age infants show a 'preference' for listening to words rather than non-words (Juscyk, Cutler & Redanz, 1993). Infants also show a 'preference' for words with phoneme structures conforming to their own language (Juscyk & Aslin, 1995). This implies that infants use the regularities in language to hypothesise word boundaries in the continuous speech stream, just like adults. Thirteen-month old infants can learn novel words from as few as nine presentations suggesting that a powerful learning mechanism for forming object-label association already exists at this age (Woodward, Markman & Fitzsimmons, 1994). By around eighteen months of age a 'spurt' of language comprehension and often production occurs that has been interpreted by Goldfield and Reznick (1992) as the triggering of a new principle of organisation into the child's understanding of the object-to-label relationship.

The features of language acquisition cited above are consistent with the effect of AoA resulting from language acquired during a 'critical' period of development, and with the proposed locus for the effects of AoA to be at the level of phonological representations. From the perspective of language acquisition it may be expected that representation of phonological *input* as well as phonological output for speech production might be a locus of AoA. Turner *et al.'s* (in press) finding of an effect of AoA in auditory lexical decision supports this proposal, because AoA affected auditory lexical decisions. Furthermore, insights from language acquisition may explain why an effect of AoA was absent in a task that required man-made or natural classifications to be made to pictures of objects (Morrison *et al.* 1992). Language associations develop between the appearance of an object and it's name. Therefore, acquisition of super ordinate categories of natural and manufactured objects would occur after the period of initial vocabulary development.

In summary, it would appear that studies on infant language development lend support to the idea that the effects of AoA arise during the critical period of language acquisition.

1.8.iv The order of acquisition.

The completeness hypothesis suggests that the effects of AoA arise from the specific processes of acquiring phonological representations during language acquisition. An alternative view is that the effects arise from a more general effect of the *order* in which information is acquired, as suggested by some researchers (e.g. Carroll & White, 1973a; Yamazaki *et al.* 1997; Gerhand & Barry, in press). To date, however, no evidence in support of an effect of acquisition order has been sought in studies of AoA.

Evidence supporting an effect of long-term temporal order of acquisition may be drawn from the neuropsychological literature. This is important because the effects of order are reported even for items acquired after the initial period of language development. Rochford and Williams (1962) investigated the similarities and differences between acquisition and breakdown of mental processes following cerebral disturbances and how these might be related to acquiring information. Rochford and Williams tested dysphasic patients and children (up to nine years of age) in an object naming paradigm. There were similarities in the dysphasic patients and children's errors and in the way the objects could be arranged in an 'order of difficulty'. Rochford and Williams found that the children's naming age was significantly correlated with patients' ability to name objects. That is to say that the earlier an object name was rated by children, the more likely patients were to produce the correct names. Rochford and Williams conclude that the object names learned first by children are the last to be lost in dysphasia, explaining the effects as resulting from the *order of acquisition.* Thus, the earlier a skill or word is acquired, the more opportunity it has to be practised. More practised items are then more resilient to disruption.

Verfaellie, Croce and Milberg (1995) report the case of SS, a 65 year old man suffering from organic amnesia, who evinced a clear effect of temporal order of acquisition. Items were words or the names of concepts for which entry into the English language were dated into hemi-decades. Pre-morbid items had entered the language between 1920 to 1970, post-morbid items between 1971 and 1990. The sets were matched for word frequency, the presence of compound words, etc. SS could recall and recognise the meaning of novel vocabulary that had entered the language after the onset of his amnesia. Novel words acquired in the 1970s were recalled and recognised significantly better than words acquired in the 1980s, even though all of the words had entered the general vocabulary after the onset of his amnesia. SS recalled and recognised very few of the 1980 items, but all of the recalled items were compound words comprising new combinations of old words (e.g. sunblock). Both controls and SS showed a similar non significant trend of temporal order for recall of words acquired between 1920 and 1970.

Shallice and Kartsounis (1993) report patient WK, a 56 year old man with a deficit for recalling people's names. Most of the faces that WK was able to name were rated as highly familiar and were of personalities famous over 20 years ago or more. For example, WK was unable to name Margaret Thatcher (the British prime minister at that time) but was able to name Harold Wilson (British prime minister twice between 1964 to 1976). WK was unable to name a single contemporary media personality, but could name historical personalities. Shallice and Kartsounis discovered this effect was not specific to peoples' names. WK was given definitions of words entering the language recently (e.g. "A device used to record TV programmes so that one can see them at a later date" - *video*). SS could name only one word that had entered the vocabulary in the past twenty years.

The patients reported above suggest that order of acquisition may be an important factor. To understand the mechanism(s) that give rise to the effect of AoA it is necessary to explore the effect of age (or order) of acquisition in a domain in which the items are learned after the initial period of language development. Therefore, processing famous faces and names provides an ideal domain in which to explore AoA because the names of celebrities are acquired continuously throughout ones' lifetime and can be dated with precision (e.g. Legrand, 1993). Recognition of famous faces and names is a particularly suitable domain because current theories of face and name processing are analogous to theories of object recognition and visual word recognition. Theories of face and name processing are briefly reviewed below.

1.9 The analogy between object, word and face recognition.

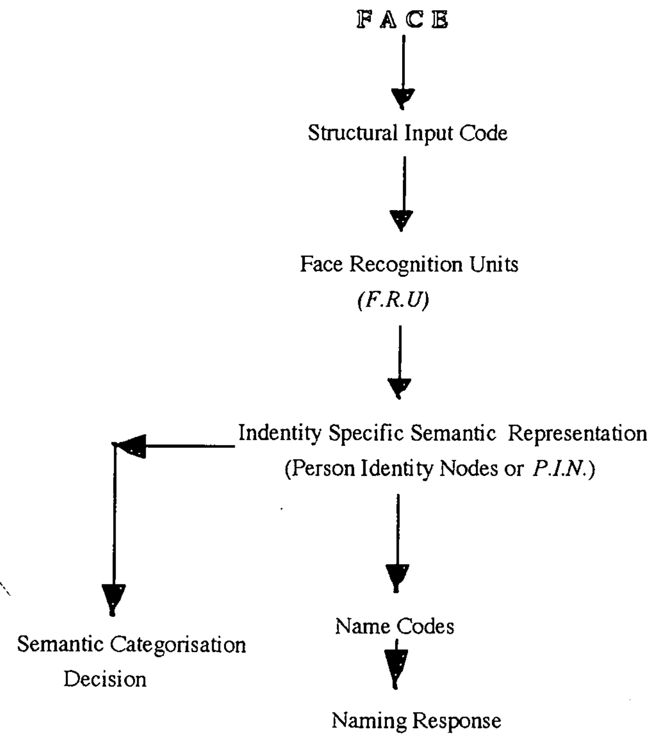
Models of familiar face recognition and naming were developed by analogy with word and object recognition and naming models. The same hierarchy of representations is assumed to be required to name a familiar face as required to name an object (see Figures 1.1, 1.2 & 1.3). A visual representation of the stimulus is activated (a recognition unit) before semantic or identity-specific semantic information can be accessed; finally a representation of the name is accessed (e.g. Bruce & Young, 1986). The major difference between object recognition and face recognition is the assumption that access to semantic information about people and their names is achieved via a Person Identity Node (or PIN) (Hay & Young, 1982). PINs play the role of token markers in memory (denoting an individual), and are assumed to be a critical difference between the processing of stimuli that take a proper name (e.g. celebrities) with those which take a common name (e.g. everyday objects).

1.9.i The Bruce and Young (1986) functional model of face processing.

Hay and Young (1982) drew on the similarities in recognising familiar words, objects and faces to develop the functional model of face recognition, analogous to the logogen model. They conceived of one face logogen (or *face recognition unit* FRU) for each known face, just as there is one logogen for each known word.

This approach was developed by Bruce and Young (1986) in the functional model of face processing, where recognising a familiar face required the face to be matched to a previously stored structural code (in the FRU) that described the appearance of the familiar face. Activation would spread from an FRU to a PIN to access identity-specific semantic information about that person. The final stage, when required, was for activation to pass from the PIN to a name code where the person's name would be accessed for name production (see Figure 1.3).

Figure 1.3: A schematic representation of the functional model of face recognition.



There are major differences between processing words, pictures and faces, some of which are relevant here. A *pictorial code* is generated in response to seeing a picture or a face. Bruce and Young regarded the pictorial code as a record of a particular static visual event, that is a general code formed for any visual pattern or picture. At this level information may be derived from unfamiliar faces. For example one may decide with reasonable accuracy the age, race and sex of unfamiliar faces by *visually derived semantic codes* generated from the structural input codes.

To recognise familiar faces one must cope with physical changes (e.g. ageing, lighting, hairstyle). Bruce and Young argue that *structural codes* must be accessed and would become elaborated through frequent exposure. These structural codes were envisaged as being stored within an *FRU*, and provide the basis for matching specific aspects of the face, to distinguish it from other faces. Bruce and Young initially proposed familiarity decisions (deciding whether a face is familiar or not) were made at this level. Thus, when any view of a familiar face is perceived the strength of activation from an FRU's signal to the cognitive system would be at a level dependent on the degree of similarity between the stored representation and that provided by structural encoding. When an FRU responds, activation spreads via the PIN to access identity-specific semantic information. The PINs were defined as entry nodes to the semantic information units in the cognitive system and play a key role in the individual identification of a known person. It is only following activation of identity-specific semantic information within the semantic system that access to *name codes* can be made. Name codes were conceived of as *output codes* that allow names to be generated. The sequential nature of the generator of these codes was postulated in the light of the literature reporting participants' ability to produce semantic information in the absence of producing a person's name, as reported in laboratory studies (e.g. Read & *Darryl* Bruce, 1982); in patients with proper name anomias (e.g. McKenna & Warrington, 1980) and in diary studies (e.g. Young, Hay & Ellis, 1985). However the validity of retrospective reports from diary studies has been questioned by Herrman (1982).

The sequential nature of the Bruce and Young (1986) functional model of face processing was based on empirical data. Young, McWeeny, Ellis, and Hay (1986) found that participants evinced faster processing latencies for a familiarity decision task than for a semantic decision task (e.g. whether a face is that of a politician or not). Young *et al.*

(1986) also reported that participants were faster to make the semantic decision than to decide whether a face belonged to a person named Michael or David (thus requiring access to the name codes). The speed of processing therefore reflects the positions of a specific representation in a processing hierarchy:- familiarity decisions are made fast and can be attributed to an early stage of processing; semantic decisions are slower than familiarity decisions but faster than name production and is therefore positioned after face recognition but before access to name codes.

When a face was presented for a familiarity decision task, a facilitation from a prior exposure to a different view of the same face was found (Bruce & Valentine 1985). However, no such facilitation occurred from a prior presentation of the person's name. The Bruce and Young model would interpret this finding in terms of the modality specific effect of repetition priming. The name accessed the same identity-specific semantic codes as the face, but as the priming occurred in an earlier component (the FRU) than identity-specific semantics no cross domain facilitation occurred. The basic assumption of importance here was that there are no common links that can be primed. The underlying assumption is that repetition priming is assumed to be caused by an increase in the weight on the connections (*or links)* between levels of representations (FRUs and PINs in this case). This assumption is explicitly implemented in Burton, Bruce and Johnston's (1990) implementation of the Bruce and Young model using an interactive activation and competition (IAC) model.

A basic assumption of Bruce and Young's model rests on names as separate features of output codes, which are accessed in a mandatory serial order, i.e. following the successful recognition of a face and accessing person specific semantic information via the PIN. This is because Bruce and Young proposed that a person's name is an essentially arbitrary label and unimportant for guiding social interactions. Bruce and

Young argue that it is because names are arbitrary labels, and convey no other information, that people's names are so difficult to recall. Having reported diary, laboratory and patient studies as evidence for separate name codes accessed after PIN's, Bruce and Young point to 'ToT' states as further evidence for the mandatory hierarchy. They interpret a typical ToT state as when face is identified as familiar although the name can not be recalled, while semantic information about a person may be recalled and used to facilitate the recall of the name. Furthermore, they point out that the opposite effect never occurs, for instance recalling a name in the absence of recalling any semantic information.

Bruce and Young (1986) cite a single patient in the literature (at that time) who could name people he knew from a photograph of a military training course he had attended without being able to provide any semantic information (Williams & Smith, 1954). This case appears to violate the hierarchy of the Bruce and Young model, as it should be impossible to access name codes without first accessing identity specific semantic representations. However, Bruce and Young suggest that this patient was amnesic and often confused "creating difficulty of interpretation". Bruce and Young argue that all the men in the picture shared the same identity-specific semantic information that made the task very difficult to interpret. They argue that it would be necessary to know if such a patient could pick out the ex-colleagues from an array containing other familiar faces (e.g. politicians) before being persuaded of the lack of identity-specific semantic information. This patient is important because he represents a specific case of the ability to name in the absence of providing identity-specific semantic information. The result, if reliable, would negate the mandatory sequential nature of the face recognition model, violating Bruce and Young's proposed hierarchy. Brennen, David, Fluchaire and Pellat (1996) report a woman with Alzheimer's dementia who could name objects in the absence of providing any semantic information. The patient was also able to name faces but was unable to provide semantic information about the people she could name. However, she appeared to know that these people were celebrities, suggesting that a small degree of semantic information may have allowed access to the name, as such this patient does not absolutely violate the Bruce and Young hierarchy.

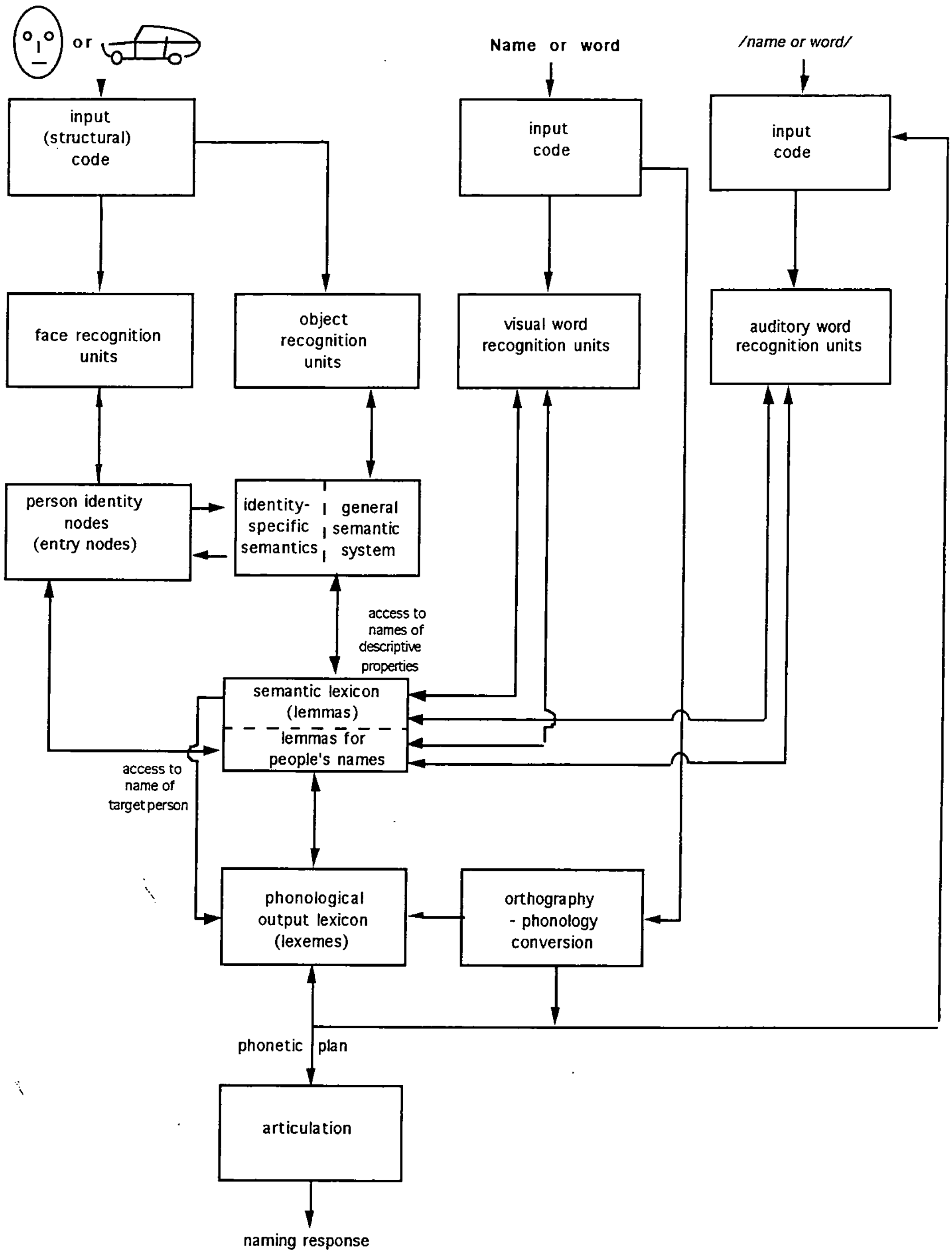
To summarise, Bruce and Young's face processing model was developed by analogy to word and object processing models and is assumed to be subject to the same hierarchy of representations.

1.9.ii The Valentine, Brennen and Brédart (1996) model of face naming.

Figure 1.4 shows the model of face, object and word recognition proposed by Valentine, Brennen and Brédart (1996) which is the most complete information-processing model in this area developed to date. It differs from earlier models in a number of respects. Most importantly, lexical access is split into two stages of representation; a semantic lexicon (*lemmas*) and a phonological lexicon (*lexemes*). This makes the model of face naming compatible with models of speech production. The semantic lexicon is assumed to be common to both language perception and production (Roelofs, 1992). Figure 1.4 shows that the lemmas for common names have direct access to semantic memory, whereas lemmas for people's names can access semantic memory only via the PINs. Experimental evidence for a common semantic lexicon is reported by Valentine, Hollis and Moore (in press). Valentine *et al.* (in press) used famous names that also constituted English words (e.g. Cilla *Black*) in repetition priming studies that investigated the relationship between reading, listening to and saying people's names. In the first experiment the priming tasks consisted of presenting famous faces for participants to *a*) name, *b*) make face familiarity decisions, or *c*) where participants were presented with printed names in a name familiarity decision task. The test task was the same for all conditions, participants were required to make familiarity decisions to printed names (identical to condition *c* of the prime task). Valentine *et al.* found that naming a face significantly primed subsequent familiarity decisions to printed names. Furthermore, the degree of priming was as great as that observed when the prime and test tasks were identical. According to the Bruce and Young model no common link exists for faces and names, therefore no priming facilitation should occur. However, this effect is accommodated by Valentine *et al.*'s model. According to Valentine *et al.* priming occurred by the strengthening of the PIN - lemma connection. The locus of the PIN - lemma link was supported by the absence of repetition priming in the face recognition task (not requiring access to the celebrity's name).

The second experiment used test tasks of either name familiarity decisions to celebrities' names (e.g. Cilla Black) or lexical decisions to the surnames presented as words (e.g. BLACK). Therefore, the data were derived from essentially the same items, serving as words or surnames. Stimuli in the priming tasks were presented either visually as printed words or auditorally as spoken words. The test tasks of familiarity or lexical decision were always presented visually. Valentine *et al.* found a significant cross-modal effect of priming. Familiarity decisions made to spoken names primed familiarity decisions to printed names. Furthermore, the magnitude of this cross-modal priming was as great as that found for within-modality priming. As would be predicted by Morton's (1979) model of word processing no cross-modal priming for the lexical decision tasks occurred when the prime condition was spoken and the test used printed words. Again, according to Bruce and Young there are no common links where priming could occur. This effect is again accommodated by Valentine *et al.* because the strengthening of the PIN - lemma connection is the common locus for repetition priming in people processing, however, the same effect cannot occur for common names because there is no equivalent token marker or *PIN*.

Figure 1.4: Valentine *et al.* (1996) functional model of face and name processing (pp 172).



In view of the strong evidence, reviewed above, for an effect of AoA on picture naming, the question arises as to whether there would be an effect of AoA on naming famous faces. Notwithstanding the analogy between naming words, objects and famous faces, the tasks do differ in a number of important respects. First, face naming requires production of a proper name whereas object naming requires the production of a common name. Therefore, the AoA of a celebrity refers to encountering an individual rather than a class of objects denoted by a common name. Second, the age at which one acquires familiarity with celebrities tends to be much later in life than the acquisition of most words (and object names), as one continues to acquire knowledge about very many new people throughout one's lifetime.

Despite these differences, it has been a logical step to explore effects on face naming that may be analogous to the reported effects of word frequency on object naming. Valentine, Brédart, Lawson and Ward (1991) explored whether the effect of the frequency of surnames in the population influenced recognition of famous people's names. They found that the effect of surname frequency was analogous to the effect of word frequency in tasks that did not require recognition of the individual (e.g. reading it aloud). However, the effect of surname frequency was analogous to the effects of facial distinctiveness (faces rated as distinctive are responded to faster than are faces rated as typical, e.g. Valentine, 1991) in tasks that did require recognition of the individual. There was an advantage for low frequency (or distinctive) surnames in a name familiarity decision task. Valentine and Moore (1995) examined the influence of surname frequency when participants produced surnames in face naming tasks. The effect of surname frequency on recalling surnames (taught to previously unfamiliar faces) was analogous to the effect of word frequency on object naming (i.e. high frequency surnames were recalled more quickly and more accurately than low frequency surnames). However, when naming famous faces there was an advantage for participants to produce low frequency surnames. Valentine and Moore point out that these results can be explained in terms of differences between the underlying nature of surname frequency and word frequency and in terms of differences in the task demands between naming objects and naming people.

Face processing therefore, appears to be a uniquely suitable and desirable domain to investigate the effects of AoA for a number of reasons. First, there is no reason to suppose that the age of acquiring a person's name and the frequency of the surname in the general population would be highly correlated. Second, the sequential hierarchy of face naming is assumed to be analogous to models of word recognition and object naming: If the effects of AoA are located at the level of the phonological output lexicon (or lexeme level) an effect of AoA would be predicted when famous names are produced. Third, if the reported effect of AoA arises purely from the structure of phonological representations established during language acquisition, the prediction arises that information acquired after the development of the phonological lexicon would not show an effect of AoA. Therefore, there are some *a priori* reasons why the influence of AoA on face processing might be expected to be rather different from its effect on word and object processing.

1.10 Summary.

This Chapter has examined some theoretical explanations of how words, object and people's names are processed by the cognitive system. It has been shown that previous research suggested that frequency of occurrence would influence processing speeds in some tasks. It has also been shown that the age when object names or words are learned can have a major impact on later processing speeds in the same tasks. However, in this review of the literature some weaknesses in current theories of word and object processing have been identified. It has been proposed that as face processing is a closely related, but distinct, domain to word and object processing, it can be used to clarify some of the issues highlighted in this review.

1.11 The organisation of this thesis.

The variables affecting face naming will be investigated in Chapter 2. This will include a description of generating experimental material and the measures of the required attributes (e.g. AoA). Chapter 2 reports Experiment 1 that followed the Morrison *et al.* (1992) paradigm as closely as possible, replacing object naming with the naming of celebrities' faces. A discussion of statistical issues pertaining to both Experiment 1 and many of the other regression studies reporting the effects of AoA will be presented. Finally, methodological problems pertaining to the use of celebrities as experimental stimuli will follow. The potential problems of interpreting the results of the multiple regression analyses from Experiment 1 are resolved in Chapter 3, where the effect of AoA is investigated in a factorial design. Experiment 2 reports the factorial analysis of selected data from Experiment 1 and a factorial replication is reported in Experiment 3. In the previous experiments participants had seen the faces three times before naming them on a fourth presentation. The possible influence of repeated presentations was investigated in Experiment 4 where faces were repeatedly named on four consecutive presentations.

Chapter 4 investigates the effects of AoA in face processing tasks not requiring a spoken response. A face familiarity decision task is described in Experiment 5 and a semantic classification task (occupational decision) is reported in Experiment 6. Chapter 5 investigates the effects of AoA on processing printed celebrities' names beginning with the reading of printed names (Experiment 7). Experiment 8 investigates AoA in a name familiarity decision task to printed names and Experiment 9 reports the results of the semantic classification (occupational decision) task to printed names.

Chapter 6 presents a summary of the findings and discusses the implications for established theories of AoA. A theoretical account of the empirical effects is proposed with suggested methodologies for future research.

CHAPTER 2: VARIABLES AFFECTING FACE NAMING.

2.1 Introduction

In Chapter 1 it was reported that some cognitive processes are affected by the frequency of a words' occurrence and by the age at which a word was learned. It was shown that these variables are highly correlated causing problems of interpretation in many studies. It was also shown that some variables affecting word and object naming also affect face naming. However, no *a priori* reasons exist to assume the same correlation would occur between surname frequency and the age of acquiring knowledge of famous people. As models of word, object and face processing have been viewed as analogous it would appear that naming famous faces provides a perfect forum in which to disentangle the correlated variables. However, because the tasks do differ in a number of respects there are also *a priori* reasons why the influence of AoA on face naming might be rather different from its effects in word and object naming. Despite the task differences, the similarities between naming words, objects and people show that it is a logical step to explore the effects of AoA where one would not predict the same problems of intercorrelation between the independent variables. Therefore, the effect of AoA on the accuracy and speed of naming celebrities' faces was investigated in Experiment 1

Surname frequency is not directly analogous to word frequency. For example, many people in the UK share the surname 'Smith', so the surname frequency will be high. The number of times the surname 'Smith' is encountered will be affected by the number of people who have that surname and how *frequently* one encounters them (personally or in the media). However, if naming a famous face is assumed to require access to a representation of a full name, that in most cases is unique to an individual, a better analogy to word frequency would be the 'familiarity' of each celebrity. Familiarity is estimated by asking participants to rate their familiarity with each item (e.g. where 1 = completely unknown, to 7 = very familiar). In this way the measure reflects media exposure of individual celebrities and the preferences of individual participants. Ratings of familiarity are likely to reflect a subjective rating of cumulative frequency (i.e. the total degree of exposure to a celebrity) because it is an estimate of the relative frequency of encountering each celebrity. Therefore, rated familiarity may be considered as a total cumulative frequency of encounters with an individual. The term cumulative frequency was used to denote a combination of AoA and word frequency (e.g. Carroll & White, 1973a). Here, cumulative frequency refers to the individual estimate of familiarity with a celebrity, explicitly including accumulated frequency of encounter. In order to differentiate between familiarity with a surname (across individuals) and familiarity with individual celebrities, measures of surname frequency and rated familiarity are used. There is no reason to suppose that familiarity, as a measure of cumulative frequency, will correlate with the celebrity's surname frequency. There is no reason to suppose that cumulative frequency will correlate with the measure of AoA because people famous in one's childhood would not necessarily be the same celebrities that one would encounter in adulthood.

Multiple regression analysis has been used in the majority of AoA studies. Experiment 1 was devised as analogous to previous work on object naming (e.g. Morrison *et al.* 1992). Multiple regression analyses were used to explore the contribution made by different variables on face naming. The use of multiple regression is appropriate for an initial exploration for a number of independent variables, especially as there is no *a priori* reason to expect inter-correlations between the variables. The intercorrelation statistics were monitored in order to test the model's strength and in an attempt to avoid some of the inherent problems of multiple regression analysis. Some of the problems of using multiple regression analysis are discussed later in this chapter (see section 2.4). A primary locus for the effects of AoA at the phonological output level should evince faster naming latencies for early over late acquired celebrities when participants name their faces aloud.

2.2 EXPERIMENT 1

2.2.i Generation of the stimuli.

A response sheet was devised that requested participants to generate famous names in one of three categories. An example of the response sheet appears in the Appendix (2.1). The categories were intended to *catch* one of three particular time-spans of participants' lives. Participants were required to name five celebrities from each category. The categories were: Early only *"five celebrities famous before your tenth birthday who are no longer in the public eye."* Still famous *"five celebrities famous before your tenth birthday who are still famous today"*. Newly famous *"five celebrities who have only become famous during the last ten years"*

The response sheets were distributed to 75 undergraduate students who were paid £1 for returning a completed sheet. When collating the data from these sheets it became clear that some celebrities were placed in all three categories. For example Michael Aspel received responses that were early only (16), still famous (9) and newly famous (8). Dividing participants into arbitrary age bands made it possible to acquire celebrities fitting into more discrete categories. The most common age band was for participants between 18 and 25 years of age. Therefore, participants in the following experiments were restricted to this age band. The selected celebrities were generated by 30 undergraduate students from Durham University (mean age = 19.19 years, s.d. = 2.03). Participants were paid £1 for completing the response sheet.

The above response sheet generated 210 celebrities' names. These names were printed (12 point Geneva font) in a pseudo-random order on 6 sheets of A4 paper. These formed the items for a rating task. An example of these sheets appear in the Appendix (2.2). The pages were stapled in a pseudo-random order with an instruction sheet on the top. A group of participants were asked to rate the names for familiarity (rated from 1 = unknown, to 7 = well known) and for the age of acquiring knowledge of celebrities. As before the AoA score gave a choice of one of three categories A = early only (famous only pre tenth birthday), B = still famous (famous both pre and post tenth birthday) and C = newly famous (become famous since tenth birthday). Finally, celebrities's occupations were requested to check accurate knowledge of celebrities. Participants were instructed to work in the order of presentation and complete all of the details for each celebrity before moving on.

Fifty rating sheets were distributed to undergraduate students at Durham University. Thirty-one sheets were returned completed (mean age =19.17 years, s.d. =1.54) participants were paid £2 on returning a completed set of sheets.

Mean scores of familiarity and AoA were calculated across participants. Celebrities rated as 'unknown' for either familiarity or AoA (70) by any of the participants were removed from the stimulus set. Celebrities with familiarity ratings below 3 were also removed from the set (24). Images of 10 celebrities were unobtainable, leaving 106 items as stimuli for Experiment 1.

2.2.ii Method

As face naming is notoriously difficult (e.g. Brédart, 1993) only the names of celebrities rated as highly familiar were employed as stimuli in the following experiments. Participants were presented with digitised images of the most recent photographs available of celebrities' faces. They were requested to provide three ratings for each celebrity: Familiarity with celebrity (or cumulative frequency), distinctiveness of the face and the age of first encountering each celebrity. The rating scales are consistent with the AoA studies reported in Chapter 1, with the exception of the 'starting' age for ratings of AoA. Typically object and word naming studies begin the rating scale at around 26 months (e.g. Morrison *et al.*, 1997). The rating scale for AoA in the following experiments began with a rating category of 'under three years of age' because knowledge of celebrities is acquired after the initial period of language acquisition. The rating tasks were followed by participants naming the same faces. Accuracy of response and naming latencies were the dependent variables.

Participants For all the experiments reported in this thesis three criteria were fulfilled: All participants spent the first 18 years of life in the UK. All participants were between 18 and 25 years of age. Participants took part in only one experiment. There were 30 participants (11 male, 19 female) with a mean age of 20.2 years (s.d. =1.6) in Experiment 1, all were students of North East Universities, and were paid £7 for their participation.

Materials and apparatus The most up-to-date images of 106 celebrities with high familiarity ratings were used.

The following details apply to all materials and apparatus in the experiments reporting face presentation in this thesis: Images of celebrities were created by scanning the most up-to-date, good quality photographs available or by capturing video stills. The pictures were monochromatic, 256 x 256 pixels in size (displayed at a resolution of 640 x 480 on a 14 inch screen) with 16 grey levels. The images were edited to obscure as much background and clothing as possible and pasted against a black background. Pictures were displayed individually in the centre of the PC screen. The experiment was controlled using the Micro Experimental Laboratory (MEL) software package (Schneider, 1988), which also randomised the order of stimuli for each presentation to each participant and logged responses and reaction times (with millisecond accuracy).

Naming latency was measured by using a voice key connected to the port of the PC. The onset of the participants' vocal response was detected by use of a throat microphone.

Design A correlational design was used which had five independent variables: The degree of rated familiarity with the celebrity; rated distinctiveness of the celebrity's face, rated AoA for knowledge of the celebrity; log surname frequency (x + 1) and the number of phonemes in the celebrity's full name. Surname frequency measures were taken from a database created by a count of non-business surnames in the 1989 South Manchester telephone directory. These measures have evinced high correlations with samples drawn from other telephone directories. For example, between South Manchester and Durham, r = .87, between North Manchester and South Manchester, r = .94, between South Manchester and Exeter r = .91 (Moore & Valentine, 1993). There were an estimated 261,105 non business surnames in the directory. Log (x + 1) of the number of occurrences of the surname per 100,000 entries was entered into the regression model. The two dependent variables were the latency to begin articulation of the correct name and the accuracy of response given.

Procedure Participants were informed the experiment had two parts, in the first part they were to make three rating responses (familiarity, distinctiveness and AoA for 106 faces) and that the second part would be explained later. Participants saw each face three time during the rating procedure. They were told that this was not a memory test.

Rating Scales The correlational design required the appropriate ratings to be obtained from the experimental participants who would also provide the naming latency data. The full set of stimuli were presented for each rating task. The instructions were phrased to emphasise that there was no right or wrong answer, but that personal opinion was the important factor. Instructions were presented on the PC screen. Participants were given as much time as required to make their decision and enter their rating. Responses were entered into the computer by moving the cursor to the chosen score and pressing the return key.

The rating tasks were always presented in a fixed order. First, familiarity ratings were made to all faces. Second, when participants were aware of the full range of facial types, the faces were rated for distinctiveness. Age of acquisition ratings were made on the third presentation. Participants pressed the space bar when they were ready to enter their rating and the appropriate rating scale was displayed. Each participant saw the images in a different random order for each rating task.

Familiarity The instructions for familiarity ratings stressed that the ratings should reflect how many times, prior to the experiment, the celebrity had been encountered by the participant on TV, films, newspapers, magazines, posters, etc. Ratings were made on a 7 point scale (1 = completely unknown, to 7 = very familiar). Rating scores were converted into a 6 point scale for analysis by removing the unknown category. Note that these instructions are entirely consistent with familiarity ratings being considered to reflect 'cumulative frequency'.

Distinctiveness Ratings of distinctiveness were made on a 6, instead of a 7 point scale as an 'unknown' response would be inappropriate, because even unknown faces can be rated for distinctiveness. Participants were instructed to imagine that they had never seen each face before and so had no knowledge of individual characteristics other than those apparent in the grey scale images (height, hair colour, etc.). Participants were asked to imagine they had to go to a railway station to meet each of these people, and to "*rate each face for how easy it would be to spot in a crowd*". They were instructed to rate very typical faces that would be difficult to spot in a crowd as 1, and very distinctive or unusual faces that would be easy to spot in a crowd as 6.

Age of Acquisition Ratings of AoA were made on a seven point scale with 1 being an unknown face. Participants estimated when they "first became aware...." of each celebrity. Number two related to a celebrity first acquired under 3 years of age, three, for a celebrity acquired under 6 years of age, four, a celebrity acquired under 9 years of age, five, a celebrity acquired under 12 years of age, six, a celebrity acquired under 18 years of age and seven, a celebrity acquired over 18 years of age. A key of this scale appeared while participants made their ratings. The scale was converted into a 6 point scale, by removing the unknown category.

The rating scales appeared on the screen when participants indicated they were ready to make their rating response. Participants were given as much time as required and advised to take a short break after completing each rating scale. It took approximately 1 to 1.5 hours to complete the rating tasks after which participants left the laboratory for a coffee break of about 20 minutes.

Face naming The naming task involved the same images as previously rated. Participants were asked to "*give the full name to each face as quickly and accurately as possible*". If they did not recognise the celebrity to say "*pass*". Response latencies (with millisecond accuracy) were recorded using a voice key and a throat microphone. Participants were familiarised with this apparatus and informed of the importance of responding as quickly as possible and of not saying anything other than their intended response.

Each trial began with the presentation of the fixation point of a "*" in the centre of a black screen and remained until participants indicated their readiness to continue. Participants were instructed to focus on the star and indicate their readiness to continue by tapping the desk. The experimenter initiated stimulus presentation. There was a warning tone for 250 msec. followed by a 250 msec. interval before the stimulus appeared. Participants attempted to name the face. The vocal response triggered the voice key and the image disappeared. The reaction time (RT) was logged by the computer. The experimenter recorded the accuracy of the response via the keyboard, only correct full names (first name and surnames) were accepted. Other responses were categorised into the type of error as invalid responses:- first name only, surname only, character name, semantic information or semantically related name, tip of the tongue state, don't know/key misfiring.

Ten different faces, not used in the experiment proper, were used in practice trials before all experimental tasks reported in this thesis. None of these data were included in the analyses. Participants were encouraged to ask any questions both during and after the practice sessions. The naming task took about 30 minutes, after which participants were debriefed.

2.2.iii Results

The rating scores for familiarity and AoA were converted into a 6 point scale by removing the 'unknown' category and equating the scale with distinctiveness for analysis.

Five items with high error scores: Eric Clapton (93%), Harold Wilson (67%), Pam Ayres (60%), Kate Bush (53%) and Pat Phoenix (53%) were removed from the analysis, reducing the error rate from 16.67% to 13%, leaving 101 items for the analyses. Out of the possible 3030 naming responses 1288 invalid responses were removed (43%) from the RT data. There were 59.94 valid responses. The invalid responses were first names only (5.48), surnames only (5.33), ToTs (4.73), semantic information/semantically related names (9.56) key misfirings / don't know (15.96). The minimum number of correct responses contributing to any mean naming latency was 14. The maximum number of responses was 30. Appendix 2.3 contains the data for all items reported in the following analyses.

In object and word naming studies, errors have been scored for completeness of response (e.g. Barry *et al*, 1997). This may be an appropriate method of reducing errors for object naming data. For example, a picture of a plant pot may be named as a pot, tub, plant holder, etc. Such alternatives would be acceptable identifiers of the picture. However, face naming is different. The response "Prime Minister" to Tony Blair's face (the British PM) may uniquely identify the person. However, this response is a semantic decision by occupation and not face naming. In terms of the face recognition model naming a face requires extra and different stage of processing which would therefore affect the speed of response. Also production of a low frequency surname (e.g. Thatcher) in response to a picture of Margaret Thatcher could be considered to uniquely identify her, whereas the response of "Smith" (a high frequency surname) to a picture of John Smith would not uniquely identify a single person, as other politicians share the same surname (Cyril Smith, Chris Smith, etc.)

Reaction times of correct naming responses. In line with procedures used in previous studies a mean reaction time for each of the remaining 101 celebrities was calculated. The individual ratings for familiarity, distinctiveness and AoA were collapsed across the 30 participants to give mean scores for each item. These mean scores were entered into the regression model together with the number of phonemes and log surname frequency as the independent variables. The descriptive statistics appear in Table 2.1.

The mean naming latency for correct full name responses was 1384 msec. (s.d.=206 msec.). Naming latency was subjected to a reciprocal transformation ($^{100}/_{x}$) to remove the negative skew from -1.04 to 0.05 (Cohen & Cohen, 1983) before entry into the multiple regression model as the dependant variable 'naming speed'. Analyses were performed using one tailed Pearson's correlation coefficients followed by simultaneous and stepwise multiple regressions.

The relationships between naming speed and the five independent variables are shown in Table 2.1. Familiarity ($p<.01$) and AoA ($p<.01$) were significantly correlated with naming speed. Celebrities rated as very familiar or acquired early in life tended to be named faster than those rated as less familiar or late acquired.

Table 2.1: Regression on naming speed data for analysis of Experiment 1

Variables	1 N.Sp.	2 Fam.	3 Dist.	4 AoA	5 Frequ.	6 Phoneme	*B*	β	Sr.^{2} (unique)
1. (DV) N.Sp	1.00	.31**	.09	-.28**	.04	-.10			
2. Familiarity		1.00	.27**	-.26**	-.07	.12	.004**	.30	.10**
3. Distinctiveness			1.00	-.37**	.10	-.03	-.000	-.08	
4. Age of Acquisition				1.00	-.07	.10	-.003*	-.23	.08**
5. Log Frequency					1.00	-.18*	.000	.04	
6. Phoneme Length						1.00	-.000	-.10	
						Intercept = .08			
Mean Scores	1384 m.s.	5.23	3.55	5.34	1.22	9.58			
s.d.	206	0.82	0.94	0.82	0.92	1.90			

R^2 = .16[a]

Adjusted R^2 = .11

R = .40**

S.E. = .01

N.Sp. = Naming Speed

*= p<.05 **= p<.01

B = Unstandardize Regression Coefficients; β = Standardised Regression Coefficients; $Sr.^2$ = Semi Partial Correlation

a. Unique variability = 13%; Shared variability = 2.5%.

There were four significant intercorrelations. Celebrities rated as very familiar tended to be rated as having distinctive faces ($p<.01$), and were also rated as acquired earlier in life ($p<.01$) than celebrities rated as less familiar. Celebrities with faces rated as distinctive had earlier AoA ratings than those with typical faces ($p<.01$). Celebrities with low frequency surnames tended to have more phonemes than celebrities with high frequency surnames ($p<.05$).

When variables are intercorrelated, as with familiarity and AoA ($p<.01$) the regression model may not be robust. To ensure that this model was valid the tolerance and variance inflation factor (V.I.F.) were examined[1] . The close proximity of the tolerance (0.97) and V.I.F (1.04) to 1 gives a good indication of the model's strength and reveals this model to be robust.

The results from the simultaneous multiple regression are shown at the bottom of Table 2.1. Sixteen per cent of the variance in naming speed was accounted for when all the independent variables were entered into the regression model, $R^2=.16$, S.E=.01; $F(5,94)=3.57$, $p<.005$. Two variables, familiarly and AoA, have significant standardised regression coefficients with naming speed. A stepwise multiple regression analysis confirmed these apparent significances. In the stepwise multiple regression variables are entered according to the diminishing magnitude of their simple correlation with the dependant variable.

1

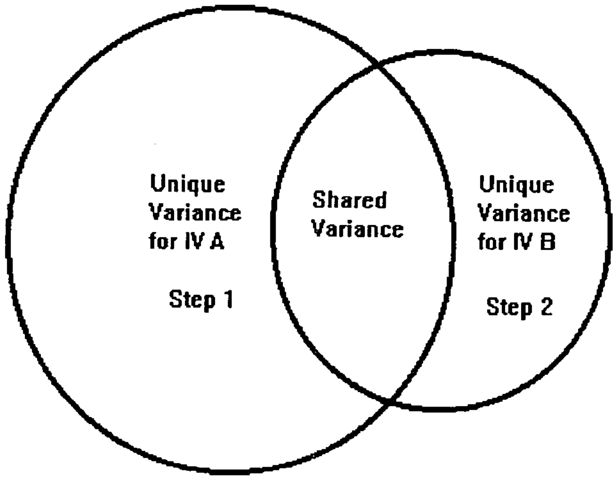
Tolerance refers to the degree to which one predictor can itself be predicted by the other predictors in the model. The tolerance of a variable i is defined as $1 - R_i^2$ where R_i is the multiple correlation coefficient when the ith independent variable is predicted from the other independent variables. The variance inflation factor is defined as the reciprocal of the tolerance, that is for the ith regression coefficient,

$$\text{VIF}\, i = 1 / (1 - R_i^2)$$

This quantity is called the V.I.F, since the term is involved in the calculation of the variance of the ith regression coefficient. As the V.I.F increases, so does the variance of the regression coefficient (Nourusis, 1993)

Familiarity was first to enter the stepwise multiple regression R^2=.10, S.E.=.01; F(1,98)=10.54, p<.002, accounting for 10% of the variance in naming speed. Age of acquisition entered on the second step R^2=.14, S.E.=.01; F(2,97)=7.99, p<.001, accounting for a further 4% of the variance in naming speed. No other variables entered the equation.

Figure 2.1: A Venn diagram showing the method of calculating how the proportion of the variance in the data can be attributed to the independent variables.



In the two stepwise regressions two calculations were performed to separate, or partial out, the contribution made by the two significant independent variable's (I.V.s). To calculate the overlap (or shared) variance apportioned to the two independent variables (as shown in the Venn diagram) the proportion of variance attributed to each variable (IV A + IV B) are added together. The sum of these two is then divided by the independent variable accounting for the least proportion of variance. The resulting figure is the proportion of variance that the two independent variables share. This is depicted by:-

$$\frac{\text{I.V. B}}{\text{I.V. B} + \text{I.V. A}} = \text{shared variance}$$

Where I.V. A = the greater proportion of the variance; I.V. B = the smaller proportion of the variance (Tabachnickk, & Fidell, 1996; pp 146-157).

The stimuli were originally selected on the basis of high ratings of familiarity to facilitate accurate face naming. By removing familiarity from the regression model any overlap (see Figure 2.1) in the predicted variance in naming speed accounted for by familiarity, but also attributable to AoA should be revealed. When familiarity was partialled out of the model, AoA significantly predicted 8% of the overall variance in naming speed. A predictive power of 2.5% had been shared between familiarity and AoA. Thus, the significant contribution of AoA in predicting naming speed was 8% of the variance Sr^2=.08, S.E.=.01; $F(1,98)=8.29$, $p<.005$. Eight percent represents half of the variance explained by all of the independent variables when entered into a simultaneous regression model.

Table 2.2: Regression on accuracy data from analysis of Experiment 1

Variables	1 C.R.	2 Fam.	3 Dist.	4 AoA	5 Frequ.	6 Phoneme	*B*	β	Sr.^{2} (unique)
1. (DV) CR	1.00	.54**	.23*	-.30**	-.11	-.00			
2. Familiarity		1.00	.27**	-.26**	-.07	.12	3.51**	.49	.29**
3. Distinctiveness			1.00	-.37**	.10	-.03	.28	.05	
4. Age of Acquisition				1.00	-.07	.10	-1.18	-1.78	.09**
5. Log Frequency					1.00	-.18*	-.066	-1.21	
6. Phoneme Length						1.00	-.19	-.70	
						Intercept = 7.42			
Mean Score	17.80								
s.d.	5.92								

R^2 = .33[a]
Adjusted R^2 = .30
R = .58**
S.E. = 4.96

C.R. = Number of Correct Responses; *= p<.05 **= p<.01

B = Unstandardize Regression Coefficients; β = Standardised Regression Coefficients; $Sr.^2$ = Semi Partial Correlation

a. Unique variability = .25%; Shared variability = 4.2%.

Accuracy of naming response. The mean number of correct naming responses (CR.) was calculated for each item across 30 participants (mean = 17.80, s.d. = 5.92). The descriptive data and results of correlational and regression analyses are shown in Table 2.2.

The data in Table 2.2 show three significant correlations with accuracy of response, the higher the familiarity ratings given to celebrities, the more likely participants were to provide a correct response ($p<.01$). The higher the distinctiveness ratings given to celebrities, the more likely participants were to name them correctly ($p<.05$). More correct responses tended to be given for celebrities rated as acquired early in life, than those rated as acquired late in life ($p<.01$). The intercorrelations between independent variables were as described for naming speed.

The simultaneous multiple regression revealed that 33% of the variation in the accuracy data was significantly accounted for by all the independent variables, $R^2=.33$, S.E.=4.76, $F(5,95)=19.47$, $p<.0001$. Only familiarity evinced a significant standardised regression coefficient ($p<.01$).

In the stepwise multiple regression familiarity accounted for 29% of the variance in the accuracy data, $R^2=.29$, S.E.=5.01; $F(1,99)=40.47$, $p<.0001$. Age of acquisition entered on the second step to significantly account for a further 3% of the variance, $R^2=.32$, S.E.=4.93; $F(2,98)=23.01$, $p<.0001$. No other variable significantly entered the equation. When familiarity was partialled out of the equation, AoA could significantly account for 9% of the variance, $Sr^2=.09$; S.E.=5.67; $F(1,99)=9.99$, $p<.005$. In calculations of unique variance AoA shared over 4% of the variance predicted by familiarity. Thus, AoA significantly predicted 27% of the variance explained by all of the independent variables in the simultaneous regression model.

Once again the intercorrelation statistics were examined (tolerance = 0.87 and V.I.F. = 1.15) and their close proximity to 1 gave an indication that this model is robust.

2.2.iv Discussion

Participants gave the correct full name in response to 47% of the celebrities' faces presented. Multiple regression analyses showed that both naming speed and accuracy were significantly predicted by rated familiarity and by rated AoA. Highly familiar celebrities were named faster and more accurately than were less familiar celebrities. Celebrities of whom knowledge was acquired early in life were named faster and more accurately than celebrities first encountered later in life. As similar results were obtained in the analysis of naming speed and accuracy of response there was no evidence of a trade-off between speed and accuracy.

To continue the analogy with object naming, it is most appropriate to think of the familiarity ratings as a subjective measure of cumulative frequency. The instructions given to participants are perfectly consistent with this interpretation. Therefore, the speed and accuracy of naming familiar faces are affected by both (cumulative) frequency and AoA. Therefore, this result is not directly analogous to the results of Morrison *et al.* (1992) who found that AoA but not word frequency affects the latency to name objects. However, a more recent study by Barry *et al.* (1997) found that both spoken word frequency and AoA affected object naming latency.

The relationship between familiarity and the ease of naming a celebrity found in Experiment 1 is unsurprising. Previously, Brédart (1993) demonstrated a positive relationship between rated familiarity (of celebrities's names) and naming accuracy. Given the great difficult many experience in recalling people's names, it would be very counter-intuitive if rated familiarity was not related to naming speed and accuracy.

In a previous study, Valentine and Moore (1995) demonstrated that distinctiveness and surname frequency affect both naming latency and accuracy. However, these effects have not been found in this experiment. A combination of factors may be influencing the present results. Firstly, in Valentine and Moore's study, participants were practised in producing *surnames* and the test condition was *surname production* to the same faces. In Experiment 1 participants were required to produce the full name, therefore *surname* frequency would be expected to have less effect. In addition, participants had not previously named the faces overtly. Naming practice reduces the number of errors and naming latencies compared to those reported in Experiment 1. It may be necessary to reduce the variance in naming data by practice before the effect of surname frequency would be observed. Secondly, factorial manipulations employed extreme values of surname frequency in Valentine and Moore's experiments, but surname frequency is a continuous variable in the present study. Distinctiveness ratings for items in Valentine and Moore's experiment were also selected to be extreme values. Again, in Experiment 1 the faces were not pre-selected to have extremes on this attribute (mean distinctiveness score = 3.55, s.d. = 0.94), and is therefore also a continuous variable.

Rated distinctiveness, familiarity and AoA were all inter-correlated. The direction of the correlations suggests that there may be some cross-talk between the ratings. Good availability of knowledge about a celebrity may produce a tendency for the celebrity to be rated as more familiar, earlier acquired and more distinctive. Although significant these inter-correlations are lower than the reported inter-correlations between AoA and word frequency in object naming studies (e.g. r = .73, Morrison *et al.* 1992).

2.3 Statistical Issues.

2.3.i Multiple Regression.

Multiple regression is a powerful statistical tool, however high inter-correlations between variables can pose problems of interpretation, especially for claims of 'independent' contributions (Morris, 1981).

Lorch and Myers (1990) expressed serious concerns over the inappropriate use of multiple regression in cognitive psychology and describe more appropriate methods of data treatment. They suggest a major difficulty with analysing repeated measures involving non-orthogonal factors lies with estimating the appropriate error term for each test of interest. The error term should be estimated by separately regressing the observations from *each* participant on each of the predictor variables. The resulting equation then represents the "best description (i.e. least squares criterion)" for each participant between the dependent variable and the set of independent (or *predictor*) variables. The resulting regression coefficients are then employed to create a participant by predictor matrix. Each regression coefficient is then analysed with a single-group *t* test, to test if it differs reliably from zero.

The procedure recommended by Lorch and Myers (1990) requires a full data set. Clearly with as much as 43% of the data points missing it would be inappropriate to estimate the missing data. Naming famous faces is notoriously difficult. The error rate found in Experiment 1 is consistent with previous studies, which have produced error rates of over 40% (e.g. Cohen, 1990b; Valentine, Moore, Flude, Young & Ellis, 1993; Valentine, Moore & Brédart, 1995). Therefore, the mean latency and accuracy for each item was entered into separate regression models. This was the procedure employed by Morrison, *et al.* (1992) and other authors and was therefore included as an initial exploration of the data and to allow for comparisons to be made with previous work. The issues raised by Lorch and Myers (1990) cannot be addressed within the constraints imposed by their recommended procedure. Therefore these issues have been addressed by subsequently selecting matched sets of stimuli to examine the effect of AoA factorially. These data are reported in Chapter 3.

Morris (1981) expressed two concerns on the limitations of stepwise multiple regression as a statistical tool. Firstly, high intercorrelations between variables can make this technique inappropriate for identifying relationships between variables because they can produce spurious relationships between factors while diluting actual relationships. The main problem is that intercorrelated variables provide very similar information, making it difficult to tease out the effects attributable to individual variables. In Experiment 1 the reported diagnostics examined the extent to which any collinearity had degraded the parameters. To this extent it was shown that although familiarity and AoA were intercorrelated the measures accepted were valid. If the data had evinced very small tolerance levels an almost linear combination of the other independent variables (IVs) would be evident. Equally, if the variance inflation factor increases so does the variance of the regression coefficient. For example, a very low tolerance (= 0.018) and very high VIF (54.51) would reveal a linear relationship between IVs and make any interpretation from the results, at least questionable (Nourusis, 1993).

Morris' second concern was that high intercorrelations make this technique inappropriate for identifying the influential variables because the order of entry into the regression model could influence the attribution of that variable's importance. This concern was addressed when the regression model was created, by incorporating the necessity of partialling familiarity out of the model and calculating the shared and unique proportion of R^2 (Cohen & Cohen, 1983; Howell, 1992; Tabachnickk & Fidell, 1996). However, Morris's concern about the possibility of stepwise multiple regression providing spurious relationships and diluting actual relationships is acknowledged. The intercorrelation statistics were examined to prevent spurious interpretations from these data. Furthermore, the data were subsequently re-analysed using a factorial design.

Many of the experiments cited in Chapter 1 employed multiple regression analyses and report 'independent' effects of AoA on cognitive tasks. However, many of the studies report intercorrelations equal to and above the simple correlation between the dependent variables. A few of the possible examples are shown below to illustrate some of Morris'

(1981) and Lorch and Myers (1990) concerns.

The study by Yamazaki *et al.* (1997) included three measures of word frequency (including a measure of familiarity), two measures of AoA (for a spoken word and the age at which a written Japanese character was typically learned) as independent variables in a multiple regression study. The dependent variable was reading speed. The simple correlations between reading speed for spoken (r = .42) and written (r = .47) words were extremely close to the intercorrelation statistic for spoken and written AoA (r = .43), although they were still included in the same multiple regressions analyses. There were high intercorrelations between written AoA and log word frequency (r = .60) and between rated word frequency and familiarity (r = .68). When variables are highly correlated as they are in this case, it is quite possible that a substantial proportion of variance attributed to one variable should be attributed to another variable.

The much cited study by Rubin (1980) also confounds some of the measures reported for the 51 properties for each of 125 words. Rubin included seven measures of word frequency and one measure of AoA. In word reading, naming latency correlated significantly with AoA (r = .63) and with the various measures of word frequency, especially the Rinsland (1945) measure of children's word frequency (r = .63). The intercorrelation between AoA and Rinsland frequency (r = .81) was greater than the correlations with the dependent variable. It should also be remembered that Rinsland's (1945) word frequency was used by Carroll and White (1973a) as objective measure of AoA.

The studies in Rubin's (1980) paper are difficult to unpack, and although it is very often cited in support of an effect of AoA, what is rarely cited is that Rubin reports "AoA is a good predictor of several semantic memory tasks, but not of recall or recognition" (pp 741). This result is inconsistent with the data from other studies (e.g. Morrison *et al.* 1992).

Butler and Haines (1979) report correlations between the latency of lexical decision and AoA (r = .33), word frequency (r = -.32) and word length (r = .28). The intercorrelations with AoA were word frequency (r = .55), word length (r = .58) and the multiplicative term of AoA multiplied by vocabulary (r = .92). These intercorrelations between variables could have de-stabilised the regression model. A variable that is highly intercorrelated may 'suppress' the variance due to other variables. The presence of a suppressor variable may be indicated by a large change between the level of the simple correlation and the level of the standardised regression coefficient which should be of a similar value (Cohen & Cohen, 1983; Tabachnickk & Fidell, 1996). In Butler and Haines' study, the simple correlation between lexical decision speed and AoA (r =.33) was reduced quite dramatically in the standardised regression coefficient (β = .045). It is important to note that Butler and Haines and other authors (e.g. Gilhooly & Gilhooly, 1979; Gilhooly, 1984) included the multiplicative term in the same analyses as the component parts of that term, inadvertently introducing a suppressor variable.

2.3.ii The distribution of age of acquisition ratings

In Experiment 1 the proportion of items rated as early acquired were much lower than one would prefer in order to accept the interpretation that AoA affected the speed and accuracy of face naming. The low proportion is evident in Table 2.1. Celebrities were selected on the basis of high familiarity ratings. However, small standard deviations were obvious for both familiarity (mean = 5.23, s.d. = 0.82) and AoA (mean = 5.34, s.d. = 0.82) suggesting that only a small proportion of celebrities were rated as very early acquired. A proportional analysis revealed this to be the case. Only 8% of celebrities were rated as acquired under the age of 12 years, and just over half of those were rated as acquired under six years of age.

Clearly the concerns over the use of multiple regression analyses and small proportion of celebrities rated as acquired very early in life presents problem for the apparent contribution made by AoA in Experiment 1. A factorial analysis of the data from Experiment 1 could clarify this problem.

2.4 Methodological Issues.

2.4.i Measures of word frequency and age of acquisition.

Perhaps one of the reasons the effects of AoA have been ignored in favour of word frequency rests on the measurements used. Chapter 1 revealed how AoA and different measures of word frequency are highly correlated. This is not surprising, given that some of the frequency measures are actually measures of when children can (or should) learn particular words. For example the Thorndike and Lorge corpus (1944) is *'The Teacher's Wordbook of 30,000 Words';* and the Rinsland's (1945) corpus *'A basic vocabulary of elementary school children.' are* explicit counts of children's written and spoken word frequencies. Therefore when researchers refer to the same 'frequency' manual identical measurements of word frequency will be found. However, many AoA researchers generate measurement of AoA by acquiring ratings for experimental material usually from those participants in the experiments. As shown in Chapter 1, these ratings are highly correlated, but not necessarily in absolute terms.

2.4.ii Four pilot studies

The ratings of stimulus attributes from Experiment 1 were used to generate sets of stimuli that differed in ratings of AoA but were matched on the other attributes. Initial attempts to identify reliably matched stimulus sets were unsuccessful. Four experiments based on items matched for other variables are reported in Appendix 2.4 in order to avoid disrupting the focus and flow of this thesis. Orthogonal manipulations of AoA and surname frequency and recency of encounter were attempted in the first two experiments. Experiment 2.4.1 manipulated AoA and surname frequency. Experiment 2.4.2 manipulated AoA and recency of encounter. Recency of encounter refers to a rating of how recently celebrities had been encountered in participants' personal domain. The requirement to match the variables of the stimuli in four cells on the design proved very difficult and resulted in only eight items for each cell. In the event these stimulus groups turned out to be too small and unstable.

Experiments 2.4.3 and 2.4.4 examined two groups of stimuli that differed in AoA but were matched on the other attributes. Items that had received a high proportion of correct responses in Experiment 1 were examined and two groups of celebrities were selected. The groups comprised twenty celebrities rated as acquired early in life and twenty celebrities rated as acquired late in life. A factorial analysis on the naming latencies of the selected items from Experiment 1 (n = 40) produced a significant difference between celebrities rated as early acquired and celebrities rated as late acquired (Experiment 2.4.3). The early and late AoA groups were used in a factorial replication of Experiment 1 (Experiment 2.4.4). There was a trend toward faster naming latencies for celebrities rated as acquired early in life, but this difference was not statistically significant. Two celebrities from the early acquired group had low familiarity ratings from participants who took part in Experiment 2.4.4 (Tommy Cooper = 2.92 & Michael Foot = 2.20). In addition early and late AoA groups differed significantly on *post hoc* ratings of familiarity ($p<.02$). Late acquired celebrities were rated as significantly more familiar than the early acquired celebrities. In summary, as these experiments do not allow clear conclusions to be drawn they are therefore discussed no further however, the data and analyses output tables are presented in the appendices corresponding to the experiment.

2.5 Interim Summary.

Chapter 2 describes how Experiment 1 was used to investigate the variables affecting face naming. Participants rated faces on familiarity, distinctiveness and AoA. Surname frequency, the number of phonemes in the name and the rated attributes formed the independent variables. Following the rating task participants named the faces. The five independent variables were entered into regression analyses. It was established that both naming speed and accuracy of response were significantly predicted by rated familiarity and by rated AoA. Celebrities rated as highly familiar were named faster and more accurately than celebrities rated as less familiar. Celebrities rated as acquired early in life were named faster and more accurately than were celebrities rated as acquired late in life.

Multiple regression analysis has been used in the majority of studies reporting an effect of AoA. Experiment 1 investigated what effects a number of variables would exert on naming famous faces. Multiple regression analysis was an appropriate tool for the initial investigations, especially as there was no *a priori* expectation of inter-correlating variables. Monitoring of the intercorrelation statistics confirmed the validity of the regression models.

Some of the problems with multiple regression analysis were noted and discussed. The results from Experiment 1 are interpreted with caution, however, and the effects of AoA established warrant further investigation. Initial attempts to manipulate the stimuli into factorial groups were not successful. These experiments are reported in Appendix 2.4. Following the unsuccessful manipulations, larger groups of early and late acquired celebrities were identified for factorial analysis (Experiment 2) and factorial replication (Experiment 3). These experiments are reported in Chapter 3.

CHAPTER 3: THE EFFECT OF AGE OF ACQUISITION IN A FACTORIAL DESIGN.

3.1 Introduction

It was shown in Chapter 1 that models of face naming developed by analogy with models of object naming. Therefore, finding that AoA affected the speed of object naming raised the question of whether it would also affect the speed of naming celebrities' faces. In Experiment 1 an effect of AoA in the domain of naming people was established for both speed and accuracy of name production. It is important to note that even when familiarity was partialled out of the regression model, AoA was the only variable to predict either speed or accuracy of name production.

The multiple regression analysis partially confirms the prediction derived by analogy with Morrison *et al.*'s (1992) data on object naming. Age of acquisition was a significant predictor of response accuracy and naming speed, although familiarity (or cumulative frequency) was found to be the major predictor of both speed and accuracy. This makes intuitive sense because only celebrities who are highly familiar to participants are likely to be named successfully.

Barry *et al.* (1997) found that spoken word frequency, name agreement and the interaction of spoken word frequency with AoA were the predominant predictors of object naming speed. The interaction was such that AoA did not affect the latency to produce high frequency names. However, early acquired low frequency names were produced significantly faster than late acquired low frequency names. By analogy, these findings suggest that no AoA effects will be apparent for celebrities rated as highly familiar.

Experiment 2 describes a factorial analysis of data from selected items from Experiment 1. The items in Experiment 2 were selected on the basis of high familiarity ratings, thus ensuring maximum availability of data points for analysis. A prediction generated by analogy to Barry *et al.'s* picture naming data would be that AoA will not affect naming speed because these items are rated as very familiar (or of high cumulative frequency). On the other hand the outcome of the multiple regression analysis of Experiment 1 would generate the prediction that celebrities rated as acquired early would be named more quickly and more accurately than would celebrities rated as acquired late in life, even with high familiarity ratings.

EXPERIMENT 2:
FACTORIAL ANALYSIS OF SELECTED DATA FROM EXPERIMENT 1.

3.2.i Method

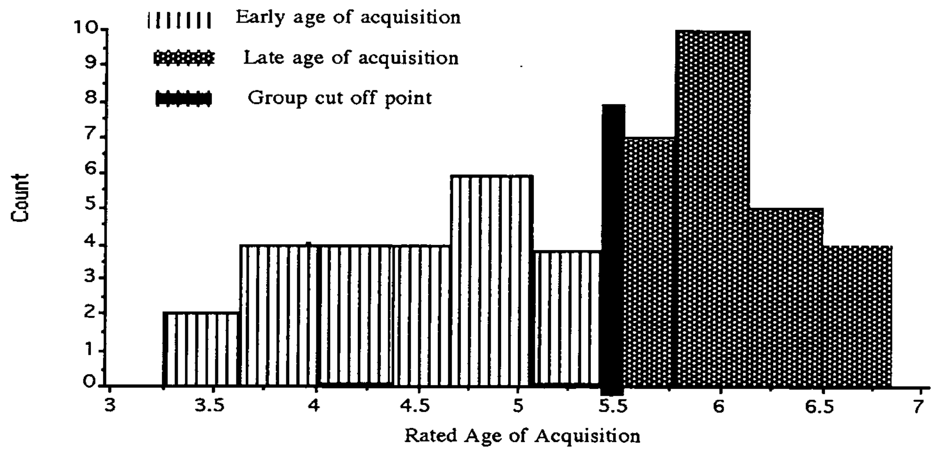
Materials Two groups of 25 stimuli were selected according to the following criteria: Celebrities in both groups had a mean rating greater than 5 on the familiarity scale (mean score = 5.75, s.d. = 0.24). One group consisted of early acquired celebrities with a mean AoA rating below 5.5, the other group consisted of late acquired items with mean AoA ratings above 5.5. The two groups of celebrities were statistically matched on all other variables. There was a significant difference between ratings of early and late AoA in a one tailed t test $t(2,48)=10.20$, $p<.0001$, no significant differences occurred between the other variables. The relevant data are shown in Table 3.1.

Table 3.1: Mean rating scores for early vs. late age of acquisition stimulus sets for factorial analysis of selected data from Experiment 1.

	AoA	Fam.	Dist.	Log. Freq	Phoneme
Early AoA	**4.51*****	**5.85** n.s.	**3.81** n.s.	**1.32** n.s.	**9.76** n.s.
s.d.	.61	.63	1.00	.89	1.36
Late AoA	**6.05**	**5.65**	**3.35**	**1.14**	**9.88**
s.d.	.34	.41	.86	.88	2.24

Key: AoA = Age of acquisition, Fam = Familiarity, Dist. = Distinctiveness, Log Freq. = Surname frequency log (x+1): Phoneme = Number of phonemes in the full name, *** = $p<.0001$: <n.s.> = $p>.1$

Figure 3.1: The frequency distribution for age of acquisition ratings of experimental items.



(Count = the number of observations)

Design, Apparatus and Procedure Age of acquisition formed one within-participants factor with two levels (early vs. late). Naming latency and accuracy of response were the dependent variables. All details of the apparatus and procedure were specified in Experiment 1. Figure 3.1 shows how the ratings of AoA were divided into two groups with the median being the 50th percentile of measures. Dividing the AoA ratings in this way meant that the highest mean rating score for early AoA (maximum early AoA score = 5.45) was just below that of the lowest mean rating score for late AoA (minimum late AoA score = 5.51). Therefore, the experiments were designed to treat participants as the random factor. Within-participants analyses have more statistical power than the between-items analyses, because within-participants analyses serve to control for individual differences in performance. The between-items analyses includes the variation due to participants in addition to variance due to the items in the error term. Analyses are reported taking participants (F_1) as the random factor, the mean data and analyses output tables are provided in the appendices. The results of the unrelated one tailed *t* test for the items' data (t_1) are also presented, the descriptive statistics appear in the corresponding tables and the mean data are provided in the appendices.

3.2.ii Results

The naming speed of correct responses and accuracy of response for the 50 critical items were isolated from the data of Experiment 1 (a list of names and data appears in Appendix 3.2.iv). The mean reaction time was 1370 msec. (s.d. = 257 msec.) and the mean number of correct full name responses was 18.98 (s.d. = 4.53) out of a maximum of 25. A one-way analysis of variance showed a significant effect on the naming speed of correct responses between celebrities rated as acquired early (mean = 1292 msec., s.d. = 236 msec.) and acquired late in life (mean = 1446 msec., s.d. = 257 msec.) $F_1(1,29)=16.76$, $p<.001$. The items analysis was also significant ($t_2(2,48)=2.54$, $p<.01$). Celebrities rated as acquired early in life were named faster than celebrities rated as acquired late in life.

There was a significant difference in the number of full names produced correctly between celebrities rated as early acquired (mean score = 19.77, s.d. = 4.31) and late acquired (mean score = 18.20, s.d. = 4.69) in a one-way analysis of variance $F_1(1,29)=19.53$, $p<.0001$. The items analysis was also significant ($t_2(2,48)=2.53$, $p<.01$). Celebrities rated as acquired early in life were named with greater accuracy than celebrities rated as acquired late in life. (The mean data and analyses output tables are provided in Appendix 3.2).

3.2.iii Discussion

Problems inherent in multiple regression designs in cognitive psychology (e.g. Morris, 1981; Lorch & Myers, 1990) were addressed initially by investigating the collinear statistics in Chapter 2 and then by carefully selecting two sets of stimuli matched on all variables except AoA in Experiment 2.

The prediction of no effect of AoA derived by analogy to Barry *et al.*'s (1997) picture naming data was not confirmed in the analysis. Celebrities rated as acquired early in life were named faster and more accurately than were celebrities rated as late acquired. All items were selected on the basis of the high familiarity ratings (or high cumulative frequency).

The significant result of the factorial analysis supports the previous interpretation from Experiment 1, that AoA affects the latency and accuracy of naming famous faces. Having established an effect of AoA in both regression and factorial analyses a full replication was carried out. The replication would establish that the ratings used for stimulus selection and the observed effect of AoA were replicable with another group of participants from the same population. The same procedure as Experiment 1 was employed with participants rating faces prior to naming them, in an experiment where only the two matched groups of stimuli identified above were included.

EXPERIMENT 3
FACTORIAL REPLICATION

3.3.i Method

Participants There were twenty-four participants (13 male and 11 female) in this experiment (mean age = 19.46, s.d. = 1.44 years), they were paid £2 for participating.

Materials and Apparatus The materials and apparatus were as described for the factorial design of Experiment 2.

Design This was a within-participants single factor design with two levels, early vs. late AoA. Naming latency and accuracy of response were the dependant variables.

Procedure The procedure was as described for Experiment 1. Here participants rated only 50 celebrities (25 early acquired and 25 late acquired) on the three attributes. Following a short break they performed the naming task on the same items. The experiment lasted approximately 25 minutes, after which participants were debriefed.

3.3.ii Results

The naming speed of correct responses and the number of correct responses to the 50 celebrities were calculated (a list of data appears in Appendix 3.3.i). The mean naming latency was 1428 msec. (s.d. = 389 msec.), the mean number of accurate responses in each condition was 16.81 (s.d. = 4.0) out of a maximum of 25.

There was a highly significant effect of naming speed between early (mean = 1310 msec., s.d. = 314 msec.) and late (mean = 1545 msec., s.d. = 426 msec.) AoA in a one way analysis of variance $F_1(1,23)=39.42$, $p<.0001$. The items analysis was also significant ($t_2(2,48)=2.62$, $p<.01$). Celebrities rated as acquired early in life were named faster than celebrities rated as acquired late in life.

There was a significant effect of accuracy between early (mean = 17.67, s.d. = 3.73) and late (mean = 15.96, s.d. = 4.14) AoA, in a one way analysis of variance $F_1(1,23)=8.44$, $p<.008$. The items analysis was also significant ($t_2(2,48)=1.32$, $p>.10$). Participants were able to correctly name more celebrities rated as acquired early in life than celebrities rated as acquired late in life.

Table 3.2: Mean *post hoc* rating scores from Experiment 3.

Age of Acquisition	Early	Late	Difference
Familiarity	**5.26** (.89)	**5.23** (.59)	n.s.
Distinctiveness	**3.84** (.99)	**3.40** (.85)	n.s.
Age of Acquisition	**4.53** (.49)	**5.72** (.37)	$t(2,48)=3.01$, $p<.001$

Key: Standard deviations are shown in parentheses. Difference = the outcome of unrelated *t* tests between ratings for early and late (AoA) age of acquisition items; ns. = not statistically significant.

Item Reliability Measures Data from participants' rating scores were analysed by unrelated *t* tests to confirm the validity of the measure used for the experimental groups (a list of data appears in Appendix 3.3.iv). *A priori* (ratings from Experiment 1) and *post hoc* rating (from participants from this Experiment) confirmed the validity of the ratings and the selection of stimulus sets (see Table 3.2).(The mean data and analyses output tables are provided in Appendix 3.3).

3.3.iii Discussion

Celebrities rated as acquired early in life were named faster and with greater accuracy than celebrities rated as late acquired. These data replicated the results from the previous experiments. Furthermore, this effect was found in a design free of the inherent problems of multiple regression analysis. It would appear that rated AoA does have a consistently robust effect on name production. This advantage was for early acquired highly familiar celebrities, as all celebrities were rated as highly familiar by *apriori* and *post hoc* ratings. This result differs from Barry *et al.'s* (1997) data for picture naming, inasmuch as they found the effect of AoA was restricted to pictures with low (spoken) frequency names.

It could be argued that data from Experiments 1, 2 and 3 are contaminated by prior exposure to the stimuli, because three ratings were obtained from participants prior to collecting the face naming data. The rating tasks were performed prior to naming because naming faces is an enormously difficult task to perform (e.g. Brédart, 1993). Priming from prior exposure usually enhances subsequent recognition and therefore may have been expected to increase the accuracy of subsequent face naming. Nevertheless, the error rate in Experiment 1 was very high (approximately 40% of trials). It may be the case that collecting ratings was not effective in enhancing face naming accuracy because the rating tasks did not require production of the celebrities' names.

EXPERIMENT 4
REPEATED NAMING OF FAMOUS FACES

3.4.i Introduction

The data from the previous experiments were derived after participants had seen the celebrities' faces during the rating tasks. It may be argued that this exposure influenced the naming speeds. Therefore, Experiment 4 was devised to investigate whether an effect of AoA would be observed in naming data from the participants' first encounter with the stimuli. A second aim was to investigate the possibility of using practice in naming faces as a method to reduce the error rate and variance of naming latency. Highly practised participants may produce more homogeneous naming data but the practice could reduce or eliminate the effect of AoA. The purpose of exploring the effect of practice was to provide data to inform the design of future experiments. Experiment 4 also serves the purpose of a further replication of the effect of AoA on naming familiar faces.

The aims of Experiment 4 meant that any effect of AoA on the first and last encounter with the stimuli would be of particular interest. Participants named the same faces repeatedly over four blocks. To equate practice in name production across items, participants were instructed not to guess the name of any celebrity they could not produce the name for, but to say "pass". When this occurred the name was supplied for participants to repeat aloud. Thus, participants were practised equally on face recognition and name production for all items. Any effect due to priming should be apparent from block 2 (the second presentation), and be maximally apparent in block 4.

3.4.ii Method

Participants There were 24 participants (9 male, 15 female) in this experiment, with a mean age of 19.3 years (s.d. = 1.3), they were paid £3 for their participation.

Materials and Apparatus The materials and apparatus used were the same as described for Experiment 1.

Design This was a within-participants two factor design with two levels of AoA (early vs. late) and four levels of Block (1 to 4). Naming latency and accuracy of response were the dependent variables.

Procedure Participants were informed that the experiment involved naming famous faces and were asked to "*give the full name to each face as quickly and accurately as possible*". If they could not name a celebrity they were instructed: "*do not guess, but say pass and the name will be provided for you. It is important that you repeat such names aloud*". Participants were prompted to repeat such names aloud on each such occurrence.

The "*" fixation point began each trial until participants indicated readiness to continue by tapping the desk. Stimulus presentation was initiated by the experimenter. Each trial commenced with a 250 msec. tone and followed by 250 msec. interval before the stimulus appeared. Participants attempted to name the face. The vocal response triggered the voice key that terminated the display of the image and the naming latency was logged by the computer. The experimenter accepted only correct full names for analysis by entering a code on the keyboard. There were four blocks in this experiment with a short break between each block. Participants were provided with the correct name if they were unable to produce it or said 'pass' and were reminded to repeat such names aloud. There were 10 practice trials from which the data was discarded.

The naming task took about 25 min, after which participants performed the rating tasks as previously described. The rating tasks took approximately 25 minutes to perform. Finally, participants were debriefed.

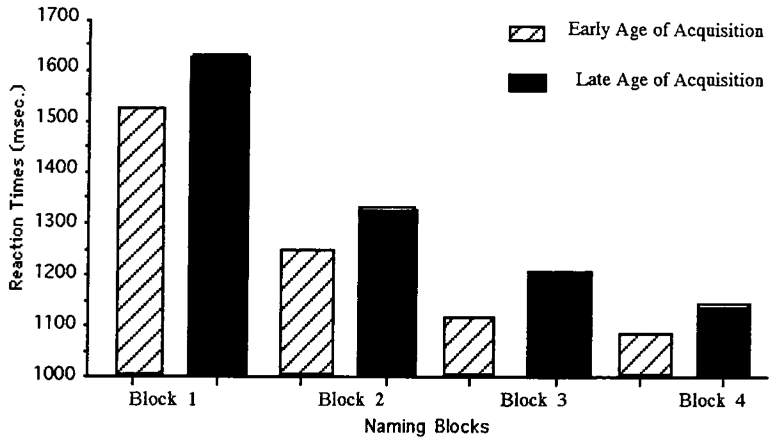
3.4.iii Results

A reciprocal transformation reduced a skew in the RT data (from .92 to .22). Mean naming speeds of correct responses and accuracy of response to the 50 celebrities were calculated, the mean data are shown in Figure 3.2 and 3.3 respectively (a list of data appears in Appendix 3.4.i).

Naming Speed From the possible maximum (4,800) data points a total of 1295 (27%) errors, key misfiring or tip of the tongue states were removed from the analyses. The mean naming latencies of correctly named faces are shown as a function of experimental block and AoA in Figure 3.2 (mean = 1578 msec, 1276 msec, 1160 msec and 1108 msec. for blocks 1 to 4 respectively). These data were subjected to a two way repeated measures analysis of variance.

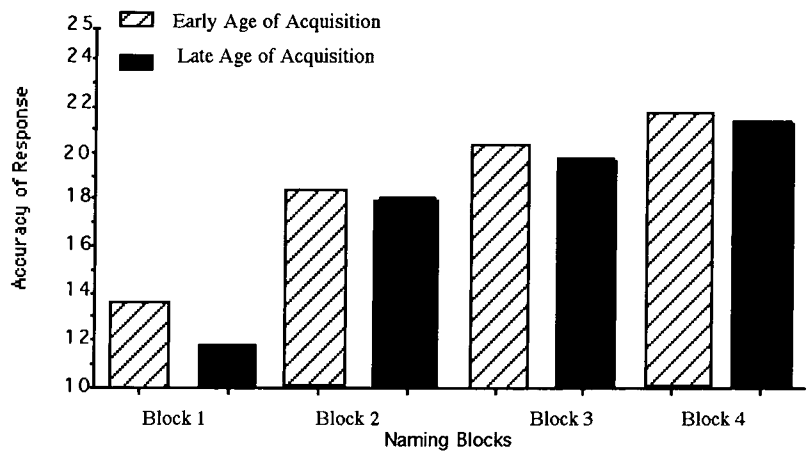
There was a highly significant main effect of block, $F_1(3,69)=56.05$, $p<.0001$, ($F_2(3,144)=85.62$, $p<.0001$). Participants named the celebrities progressively faster as the stimuli were repeated across blocks. Multiple comparisons showed that naming speed increased significantly between blocks 1 and 2 $F_1(1,23)=57.79$, $p<.0001$ (mean latency decreased by 302 msec.), that was also significant by items $t_2(2,48)=8.30$, $p<.0001$. Naming speed also increased significantly between blocks 2 and 3 by participants $F_1(1,47)=18.50$, $p<.0001$ (mean latency decreased by 116 msec.), and by items $t_2(2,48)=4.51$, $p<.0001$ and between blocks 3 and 4, for participants $F_1(1,47)=4.20$, $p<.05$. (mean latency decreased by 52 msec.), and for items $t_2(2,48)=2.99$, $p<.01$. There was a highly significant main effect of AoA for participants $F_1(1,47)=13.99$, $p<.001$, and for items ($t_2(2,48)=1.32$, $p<.05$). Participants were faster to correctly name celebrities rated as acquired early in life than late-acquired celebrities (mean = 1233 msec. vs. 1328 msec., respectively). There was no interaction between block and AoA for participants or items F_1 and $F_2 < .1$, lists of data appear in Appendix 3.4.i and 3.4.iv respectively).

Figure 3.2: Mean reaction times for repeated naming of celebrities faces.



Accuracy The mean number of correct responses for each block are shown (in Figure 3.3) as a function of experimental block and AoA (mean = 12.77, 18.33, 20.33 and 21.54 for blocks 1 to 4 respectively). There was a highly significant main effect of block, $F_1(3,69)=116.37$, $p<.0001$, ($F_2(3,144)=174.15$ $p<.0001$). Participants produced more correct names with repetition. Multiple comparisons showed that participants' accuracy of response improved significantly across blocks 1 and 2 by participants (difference = 5.56) $F_1(1,47)=152.47$, $p<.0001$, and by items ($t_2(2,48)=11.48$, $p<.0001$); between blocks 2 and 3 (difference = 2.00) by participants $F_1(1,47)=33.93$, $p<.0001$, and by items ($t_2(2,48)=5.24$, $p<.0001$); and between blocks 3 & 4 (difference = 1.21) by participants $F_1(1,47)=18.94$, $p<.0001$, and items ($t_2(2,48)=4.17$, $p<.0001$). There was a significant main effect of AoA for participants $F_1(1,23)=6.99$, $p<.02$. The items analysis approached significance ($t_2(1,48)=.98$, $p<.2$). Celebrities rated as acquired early in life were named with greater accuracy than celebrities rated as acquired late in life (18.73 vs. 17.76, respectively). There was no interaction between block and AoA F_1 and $F_2< 1$. Lists of data appear in Appendix 3.4.i and 3.4.v respectively).

Figure 3.3: Mean accuracy scores for repeated naming of celebrities' faces.



Analysis of Naming Speed and Naming Accuracy by Block.

The stated aims of the experiment required separate analysis of the effect of AoA for the first and last presentation. For completeness all blocks were analysed separately (a list of data and tables appears in the Appendix section 3.4.i to 3.4.v).

Block 1 Forty-nine percent of trials were excluded from the analysis of naming latency (errors, key misfiring or tip of the tongue states: 45.2% of early AoA items and 52.3% of late AoA items). The mean naming latency was 1578 msec. (s.d. = 307 msec.). A reciprocal transformation reduced a skew in the data (from .58 to .28). In a one way analysis of variance there was a significant effect of AoA on naming speed for participants (early mean = 1526 msec., s.d. = 305 msec.; late mean = 1630 msec., s.d. = 304 msec.) $F_1(1,23)=4.69$, $p<.04$. The items analysis was also significant ($t_2(2,48)=.47$, $p>.05$). The mean number of accurate responses was 12.77 (s.d. = 4.71) out of 25 trials in each experimental condition (67.2%). A one way analysis of variance revealed a significant effect of AoA on the accuracy data (early mean = 13.71, s.d. = 4.95; late mean = 11.83, s.d. = 4.36), for participants $F_1(1,23)=7.50$, $p<.01$; and for the items analysis $t_2(2,48)=1.36$ $p>.05$). On the first presentation, participants were significantly faster and more accurate to name celebrities rated as acquired early in life than to name celebrities rated as acquired late in life.

Block 2 Twenty-seven percent of trials were excluded from the analysis of naming latency (errors, key misfiring or tip of the tongue states: 25.7% of early AoA items and 27.7% of late AoA items). The mean naming latency was 1276 msec. (s.d. = 237 msec.). A reciprocal transformation reduced a skew in the data (from .94 to .09). There was a highly significant effect of AoA on naming speed in a one way analysis of variance for participants (early mean = 1219 msec., s.d. = 214 msec.; late mean = 1334 msec., s.d. = 249 msec.) $F_1(1,23)=8.55$, $p<.008$. The items data was also significant ($t_2(2,48)=1.67$, $p>.05$). The mean number of accurate responses was 18.33 (s.d. = 3.47) out of 25 trials in each experimental condition (73.3%). There was no effect of AoA in the accuracy data for participants (early mean = 18.58, s.d. = 3.50; late mean = 18.08, s.d. = 3.49, $F_1(1.23)=.72$, $p>.1$. The between items analysis was significant $t_2(2,48)=.41$, $p>.05$). On the second presentation participants were significantly faster to name celebrities rated as acquired early in life than celebrities rated as acquired late in life.

Block 3 Nineteen percent of trials were excluded from the analysis of naming latency (errors, key misfiring or tip of the tongue states: 16.5% of early AoA items and 20.8% of late AoA items). The mean naming latency was 1160 msec. (s.d. = 244 msec.). A reciprocal transformation reduced a skew in the data (from 1.20 to .26). There was a significant effect of AoA on naming speed in a one way analysis of variance for participants (early mean = 1116 msec., s.d. = 221 msec.; late mean = 1205 msec., s.d. = 263 msec.) $F_1(1,23)=4.17$, $p<.05$. The items analysis was also significant ($t_2(2,48)=1.55$, $p>.05$). The mean number of accurate responses was 20.33 (s.d. = 3.28) out of 25 trials in each experimental condition (81.3%). There was no effect of AoA on the accuracy data for participants (early mean = 20.88, s.d. = 2.72; late mean = 19.79, s.d. = 3.74), $F_1(1,23)=3.03$, $p>.1$. The items analysis was significant ($t_2(2,48)=1.18$, $p<..05$). On the third presentation participants were significantly faster to name celebrities rated as acquired early in life than celebrities rated as acquired late in life.

Block 4 Fourteen percent of trials were excluded from the analysis of naming latency (errors, key misfiring or tip of the tongue states: 13.0% of early AoA items and 14.7% of late AoA items). The mean naming latency was 1108 msec. (s.d. = 222 msec.). A reciprocal transformation reduced a skew in the data (from .97 to .04). The difference in naming speed between early and late AoA was not significant for participants (early mean = 1073 msec., s.d. = 208 msec.; late mean = 1143 msec., s.d. = 234 msec., $F_1(1,23)=3.43$, $p<.08$; or by items ($t_2(2,48)=.41$, $p<.08$). The mean number of accurate responses was 21.54 (s.d. = 2.39) out of 25 trials in each experimental condition (86.2%). There was no significant difference between early and late AoA in the participant's accuracy data (early mean = 21.75, s.d. = 2.35; late mean = 21.33, s.d. = 2.46, $F_1(1,23)=1.78$, $p>.1$. The items analysis was significant ($t_2(2,48)=.47$, $p>.05$).

The data in Figures 3.2 and 3.3 reveal a consistent pattern of results. Participants named celebrities rated as acquired early in life faster than they named celebrities rated as acquired later in life. This effect was significant in blocks 1 - 3, but just short of statistical significance in block 4. Participants named early acquired celebrities more accurately than they named late acquired celebrities in block 1. The effect of AoA on accuracy was not significant in blocks 2 - 4.

Table 3.3: Mean *post hoc* rating scores from Experiment 4.

Age of Acquisition	Early	Late	Difference
Familiarity	**5.17** (.80)	**5.39** (.52)	n.s.
Distinctiveness	**3.78** (.92)	**3.36** (.85)	n.s.
Age of Acquisition	**4.50** (.44)	**5.80** (.37)	$t(2,48)=9.0$, $p<.001$

Key: Standard deviations are shown in parentheses. Difference = the outcome of unrelated *t* tests between ratings for early and late (AoA) age of acquisition items; ns. = not statistically significant.

Item Reliability Measures Data from participants' ratings were analysed by unrelated *t* tests to confirm the validity of the measure used to select the two sets of stimuli. *Post hoc* ratings from participants from this Experiment confirmed the validity of the stimulus sets (see Table 3.3) a list of data appears in the appendices (Appendix 3.4.viii).

3.4.iv Discussion

Participants were consistently faster and more accurate to name celebrities rated as acquired early in life than they were to name celebrities rated as acquired later in life, even on the first presentation. This result supports the interpretation of a robust effect of AoA in face naming. Furthermore, there is no support for any suggestion of a possible artefact arising from repeated exposure to the stimuli influencing the reported effect of AoA. In fact, the effect of repeatedly naming faces in Experiment 4 served to diminish the effects of AoA. The effect on naming latency was not statistically significant in block 4. The effect of AoA on accuracy of naming response observed in block 1 was not present in blocks 2 - 4. In all cases the differences in accuracy and latency, even when not significant, were in the direction of faster and more accurate naming of early acquired celebrities. The lack of statistical significance in Block 4 is most probably due to ceiling effects.

Practice naming celebrities clearly increased naming accuracy and reduced naming latency. However, the trend for the effects of AoA to diminish with practice means that it would be unwise to use practice *naming* faces to enhance accuracy or reduce the variability of naming latency in future experiments investigating the effects of AoA. Experiments 1, 2 and 3 showed robust effects of AoA in naming celebrities on the fourth presentation of the stimuli. However, participants had rated the faces rather than named them on the previous exposures. The effect of mere exposure to the celebrity faces was very different to practice naming faces as shown by the accuracy of naming in block 4 of Experiment 4 was considerably higher than in Experiment 3 that used the same stimulus set (86% vs. 67% respectively). A reliable effect of AoA on naming accuracy and latency was found in Experiment 3 but neither dependant variable showed a significant effect of AoA in block 4 of Experiment 4.

3.5 Interim Summary

As models of face naming were developed by analogy to models of object naming, the question of whether AoA affects the speed of naming celebrities' faces was raised. It has been demonstrated that a robust advantage in both speed and accuracy of name production for early acquired over late acquired celebrities' names in both multiple regression and factorial designs. Participants evinced a facilitation in speed and accuracy when producing celebrities' names rated as acquired early in life, both with and without prior presentation of the face. As far as the author is aware, studies of object naming have not reported an effect of AoA on naming accuracy (e.g. Morrison *et al.* 1992; Morrison & Ellis, 1995; Barry *et al. 1997*). Object naming is less error prone than naming people, which may cause ceiling effects in the accuracy data, preventing such statistical analysis.

These results establish that an effect of AoA on name production can be found in a task that requires production of proper names, acquired much later in life than the acquisition of object names.

CHAPTER 4: THE EFFECTS OF AGE OF ACQUISITION ON FACE PROCESSING TASKS NOT REQUIRING A SPOKEN RESPONSE.

4.1 Introduction

The previous experiments explored the effects of AoA on naming famous faces in both multiple regression and factorial designs. There was a consistent advantage in naming celebrities rated as acquired between the ages of 6 to 12 years of age, such celebrities were named faster and with greater accuracy than celebrities rated as acquired above this age. Familiarity (or cumulative frequency) was the major predictor of speed and accuracy in Experiment 1. When familiarity was partialled out of the regression model only AoA significantly predicted both naming speed and accuracy of response. The effect of AoA remained significant when familiarity was controlled.

The effect of AoA on naming celebrities' faces cannot be explained in terms of any mechanism of language acquisition. The early AoA ratings for celebrities were between approximately 6 and 12 years of age, while the majority of early acquired object names are typically rated as acquired between the approximate ages of 2 to 6 years of age. An explanation in terms of order of acquisition seems to be a more promising approach. Therefore, a clear understanding of the effect of AoA in person recognition is vital to elucidate the mechanism(s) that produces an effect of AoA.

The aim of this chapter is to investigate the locus of AoA in face processing tasks. Two tasks not requiring the production of a name were used to investigate the effect of AoA. Experiment 5 uses a face familiarity decision task. Experiment 6 requires a decision based on identity-specific semantic information. Research on picture naming suggests that the locus for AoA is at the stage of speech production (lexical access). A locus at this level generates the prediction for no effect of AoA in face familiarity decision or semantic classification, because neither task requires lexical access.

EXPERIMENT 5

FAMILIARITY DECISION TASK TO FACES.

4.2.i Introduction

The earlier experiments have demonstrated a robust effect of AoA for naming famous faces. In the following experiments it was important to use a set of stimuli for which the effect had been established empirically. As reported in the four experiments in Appendix 2.4, establishing a firm set of items with replicable ratings was not without its difficulties. Therefore, the same stimulus sets as used in Experiments 2 to 4 were used in the following experiments. To ensure that the two groups were equally valid for participants in the following experiments, *post hoc* ratings were obtained from participants to confirm the validity of stimulus allocation to 'early' and 'late' experimental groups. The analyses of these ratings were used to confirm that the items remain consistently unbiased by other variables. There is a distinction between the measures of rated familiarity and the latencies in which participants can make a speeded response to the picture of a face. The former reflects a considered account of how many times they have encountered that person. The latter reflects an immediate 'on-line' decision as to whether the face is known.

4.2.ii Method

Participants: There were 24 participants in Experiment 1 (7 male, 17 female) with a mean age of 22.46 years (s.d. = 1.80), they were paid £2 for their participation.

Face Familiarity Decision Task.

Materials: All the celebrities used as critical items in these experiments were described in the previous factorial manipulations in Chapter 3.

Two groups of 25 stimuli were matched on all variables except AoA which differed significantly between early and late AoA in a one tailed *t*-test $t(2,48) = 10.20$, $p<.0001$. *Post hoc* ratings of the celebrities' faces were collected using the same pictures and are shown in Table 4.1.

The stimulus set for Experiment 5 was completed by adding 50 unfamiliar faces to the set of 50 famous faces described above. The unfamiliar faces were presented in the same format as the famous faces and with the groups scores were matched to celebrity faces on measures of distinctiveness (the collection of ratings for the unfamiliar faces were described in Valentine & Moore, 1995).

Design: This was a within-participants one factor design with two levels of AoA, (early vs. late). Face familiarity decision latency and accuracy of response were the dependent variables.

Apparatus and Procedure: Each face was presented individually in the centre of a blank computer screen. Participants were asked to *decide as quickly and accurately as possible* whether or not each face was that of a famous person. Responses were made via a hand-held response box. Participants pressed the "YES" button for a famous face and the "NO" button for an unknown face. The button push terminated the display and the decision latencies were logged by the computer. A MEL software package controlled the experiment, randomising the order of presentation of the 100 stimuli to each participant and recorded responses and reaction times (with millisecond accuracy).

Each trial began with the presentation of the fixation point of a "*" in the centre of a blank screen. Participants were instructed to focus on the star. After an interval of 250 msecs. the fixation point cleared from the screen, a warning tone sounded for 250 msecs. followed by a 250 msecs. interval before a face appeared in the centre of the screen. Participants made their response by pushing one of the two buttons, the latency and accuracy of response were recorded by the computer and the image disappeared from the screen.

The face familiarity task took approximately 10 minutes. After a short break participants rated the celebrity faces for familiarity, distinctiveness and AoA which took approximately 25 minutes. Finally participants were debriefed and were asked whether they had experienced any particular difficulty with the experimental or rating tasks, any such comments were recorded.

4.2.iii Results

A total of 125 incorrect responses were removed from the data. Mean latencies of the remaining correct responses were calculated for analysis. The mean reaction time of correct familiarity decisions to famous faces was 662 msec (s.d. = 81 msecs.). The mean accurate response was 22.40 (s.d. = 2.31).

A one way analysis of variance on participants' latency data showed that there was a highly significant difference between the latency of familiarity decisions made to early acquired (mean = 642 msecs., s.d. = 86 msecs.) and late acquired celebrities' faces (mean = 682 msecs., s.d. = 76 msecs.) $F_1(1,23)=39.60$, $p<.0001$. The items analysis was also significant ($t_2(2,48)=1.72$, $p<.05$).

A similar analysis showed no significant difference between participants' accuracy of early acquired (mean = 22.67, s.d. = 2) and late acquired celebrities' faces (mean =

22.12, s.d. = 2) $F_1(1,23)=1.07$; $p<.3$. The items analysis approached significance ($t_2(2,48)=.55$, $p<.03$).

The *post hoc* ratings (shown in Table 4.1) confirmed the difference between the ratings of AoA and no differences between the stimulus sets on the other variables. Familiarity decisions to celebrities rated as early acquired were faster than to late acquired celebrities.

Table 4.1: The mean *post hoc* rating scores from Experiment 5.

Age of Acquisition	Early	Late	Difference
Familiarity	**5.14** (.69)	**5.32** (.63)	n.s.
Distinctiveness	**3.95** (.97)	**3.57** (.84)	n.s.
Age of Acquisition	**4.03** (.75)	**6.20** (.45)	$t(2,48)=9.88$, $p<.001$

Key   standard deviation in parentheses, ns. = not statistically significant.

4.2.iv Discussion

The data from Experiment 5 has shown that participants were faster to make familiarity decisions to early acquired celebrities' faces than they were to late acquired celebrities' faces. Therefore, an effect of AoA was observed despite that fact that the two stimulus sets were matched on rated familiarity and that name production was not a task requirement. Analysis of the ratings collected from participants in the face familiarity decision task confirmed the validity of the two stimulus sets. There are two reasons why the accuracy data were not significant. Firstly, there were ceiling effects, 90% responses given were correct. Secondly, familiarity decision tasks are designed to give high proportions of correct responses to maximise reaction time data for analysis.

The face familiarity decision task was developed as an analogue of the lexical decision task (Bruce, 1983). Therefore, it could be argued that the effect of AoA in face familiarity decision is analogous to the effect of AoA in lexical decision. Age of acquisition does have an effect on reaction times of lexical decision. The effect on lexical decision is attributed to automatic activation of phonology (e.g. Morrison & Ellis, 1995; Gerhand & Barry, in press). Clearly, there is no automatic activation of phonology from a famous face, indeed, faces are notoriously difficult to name (e.g. Brédart, 1993; Burke *et al.* 1991; Valentine, *et al.* 1996). Using a repetition priming paradigm Valentine *et al.* (in press) have shown that names are not automatically activated in a face familiarity decision task. In conclusion, this result is not consistent with a single locus for the effect of AoA in face processing to be at the stage of name retrieval, because no naming response was required. Face familiarity decisions are assumed to be based on activation of the PINs (Burton *et al.* 1990). Therefore, the data suggest that there must be a locus of AoA in the processing at, or prior to the PINs.

EXPERIMENT 6

SEMANTIC CLASSIFICATION TO FACES.

4.3.i Introduction

In Experiment 6 the locus of AoA in face processing was investigated further by requiring participants to make a decision to famous faces, based on identity-specific semantic information. This task requires access to identity-specific semantic representations that are accessed by PINs. It should be noted that although access to identity-specific semantics is not a logical requirement when naming a face, it is almost always the case (in normal participants and virtually all brain-injured patients) that semantic information can be accessed if the name can be accessed. Furthermore, semantic information such as a celebrity's occupation is accessed faster than their name. (See Burton & Bruce, 1992 and Brédart, Valentine, Calder & Gassi, 1995 for discussions of this issue). If the locus of AoA is at the stage of lexical access, no effect of AoA would be predicted in Experiment 6. However, if the locus is at or prior to the PINs it would be predicted that semantic decisions to early acquired celebrities would be made faster than to later acquired celebrities.

4.3.ii Method

In designing the semantic task for this experiment it was important to use the same stimulus sets, having demonstrated an effect of AoA for this set of items previously. However, the two groups did not easily divide into typical semantic categorisations (e.g. dead vs. alive; politician vs. singer, etc.). Items were divided into two broad categories of 'occupation'. The task was for participants to decide whether or not each celebrity was famous for appearing in or hosting 'chat-type' shows, including both serious and humorous types of program.

Participants: There were 24 (13 male, 11 female) participants in this experiment (mean age = 20 years, s.d. = 1.9), they were paid £2 for their participation.

Materials and Apparatus: Each stimulus group (early vs. late AoA) included 8 celebrities from 'chat-type-shows' and 17 celebrities from other occupations. Fifty celebrities, 34 from 'chat-type-shows' and 16 from other occupations were included as filler items (a list of 'filler' celebrities appear in Appendix 4.2.iv). Thus there were 50% of the stimuli in each category.

Design: This was a within-participants one factor design with two levels of AoA (early vs. late). The dependent variables were latency and accuracy of classification response.

Apparatus and Procedure: The 100 images were presented in a random order. Participants were instructed to *decide whether or not celebrities were famous for hosting or consistently appearing in 'chat-type-shows'* from both serious and humorous types of programs. Instructions were presented on a 14 inch PC screen and emphasised the need for speed and accuracy. The definition of 'chat-type-show' appeared on the screen with examples of the definitions.

"Your tasks is to decide whether or not each celebrity you see is famous for hosting or captaining a 'chat-type-show'. The definition of 'chat-type-show', is any media programme where an individual interviews different people. For example, Jeremy Paxman, (host of current affairs TV programmes) or Terry Wogan (host of TV and radio programmes). Also included in the 'chat-type-show' category are celebrities who chair quiz shows. For example, Clive Anderson (the chair of the game show 'Whose line is it anyway?') and celebrities who consistently captain quiz teams, for example, Garry Lineker and Bill Beaumont (captains of opposing teams on the TV quiz programme' A Question of Sport').

Specifically excluded are celebrities who briefly appear in any or all of these programmes. For example when promoting themselves or their latest book, record, etc. For example, Jeffrey Archer (ex-politician and novelist), Carol Thatcher (daughter of an ex-prime minister and 'journalist')."

A button push on the hand-held box was the required response. One button marked 'YES' for 'chat-type-show' the other marked 'NO' for *any* other occupation. Decision latencies and response accuracy were logged by the computer. MEL software was used to control the experiment as described above.

Participants were encouraged to ask any questions both during and after the practice sessions. The semantic classification task took approximately 10 minutes, after which participants completed the rating tasks. Finally participants were debriefed.

4.3.iii Results.

A total of 163 errors were removed from the data. Mean classification latencies of the remaining correct responses for the 50 critical celebrities' faces were calculated for the two groups. The mean classification reaction time was 898 msecs. (s.d. = 261 msecs.). A reciprocal transformation was used to reduced a skew in the data (from 2.28 to -.63) prior to analysis. The mean number of correct responses was 21.60 (s.d. = 1.98).

A one-way analysis of variance showed a significant difference between the time it took participants to classify celebrities' faces rated as early acquired (mean = 920 msecs, s.d. = 285 msecs.) and those rated as late acquired faces (mean = 875, s.d. = 239 msecs), $F_1(1,23)=5.06$, $p<.03$. The items analysis was also significant ($t_2(2,48)=1.80$, $p<.04$). Participants were faster to correctly attribute the correct category for celebrities rated as acquired *late* in life.

There was no significant difference in accuracy data between celebrities' faces rated as early acquired (mean = 21.50, s.d. = 1.77) and late acquired (mean = 21.71, s.d. = 2.20); F_1 and $t_2<.1$.

Participants were faster to make semantic categorisations of celebrities' faces rated as *late* acquired than to faces rated as early acquired.

Table 4.2 Mean *post hoc* rating scores from Experiment 6.

Age of Acquisition	Early	Late	Difference
Familiarity	**5.68** (.50)	**5.81** (.59)	n.s.
Distinctiveness	**3.62** (.72)	**3.70** (.86)	n.s.
Age of Acquisition	**4.23** (.58)	**6.01** (.35)	***t*(2,48)=12.09, *p*<.0001**

Key standard deviation in parentheses, ns. = not statistically significant.

Item Reliability Measures: Data from participants' ratings were analysed by unrelated *t* tests and as shown in Table 4.2 confirmed the validity for the selection of stimulus sets, i.e. the *post hoc* ratings differed significantly in measures of AoA but not in measures of familiarity or distinctiveness.

4.3.iv Discussion.

Participants were faster to make semantic occupational categorisations to late acquired celebrities' faces than to faces rated as early acquired. Taken with the results of the previous experiments, the effect of AoA on face processing tasks can be summarised as follows. There was an advantage for early acquired items in a face familiarity decision task and for face naming but there was an advantage for *late* acquired items in a semantic decision task. According to the model of face recognition and naming, access to face recognition units and PINs is a prerequisite to any semantic decision. Therefore an advantage for early acquired items would be predicted. The result suggests that memory for identity-specific semantic information may be organised rather differently to representations of familiar faces, names and words. Access to semantic information appears to be faster for late acquired information. It is possible to propose an explanation for this anomalous result. In the Valentine, *et al.* (1996) functional model of face recognition (see Figure 1.4). The link from a celebrities' PIN to lemma selection may have been activated automatically, therefore errors in recognition (and naming) would influence the time taken for activation to pass back to the semantic system. If this were the case, then one would not predict any effect of AoA in a task where participants are provided with the name, this will be tested in Experiment 9.

Morrison *et al.* (1992) found no effect of AoA when participants made semantic decisions to objects (natural vs. man-made). Therefore, by analogy, no effect would be predicted from semantic decision to familiar faces. The advantage for late acquired celebrities' faces found in Experiment 6 may have been caused by the somewhat contrived nature of the classification task employed. The interpretation of AoA in famous face processing tasks may be clarified by exploring the effect of AoA in analogous tasks using celebrities' names as stimuli. Experiment 7 investigates the effect of AoA on the time taken to read aloud famous names. By analogy with word naming, the names of early acquired celebrities should be read aloud more quickly than the names of late acquired celebrities (e.g. Gerhand & Barry, 1998).

CHAPTER 5: INVESTIGATING THE EFFECTS OF AGE OF ACQUISITION ON PROCESSING PRINTED NAMES.

5.1 Introduction

The aim of Chapter 5 is to investigate the locus of AoA in name processing tasks. Experiment 7 would established whether an effect of AoA would be apparent when participants read celebrities' names aloud. Two tasks not requiring name production were used to investigate the effect of AoA on name processing. Experiment 8 used a name familiarity decision task. Experiment 9 required a decision based on identity-specific semantic information to the printed name. A locus at the speech production level (lexical access) would predict an effect of AoA for the reading task, but would not predict an effect of AoA in the other two tasks, because they do not require speech production. However, a single locus at speech production cannot explain the significant effects of AoA reported in Experiments 5 and 6 (Chapter 4).

Experiment 7, was designed as analogous to reading words aloud (e.g. Gerhand & Barry, 1998). The proposed locus for the effect of AoA at the phonological output lexicon would generate a prediction of significantly faster reading latencies for early acquired over late acquired celebrities' name. Participants will be presented with the written names of celebrities and required to read the names aloud as quickly as possible.

EXPERIMENT 7
READING PRINTED NAMES.

5.2.i Method

Participants: There were 24 participants in Experiment 7, (9 male, 13 female) with a mean age of 19.96 years (s.d. = 1.23), they were paid £2 for their participation.

Design: Age of acquisition formed one within-participants factor with two levels (early vs. late). Reading latency and accuracy of response were the dependant variables.

Stimuli Experiment 7 used the printed names of the celebrities from Experiments 2 to 6. The names were printed in 12 point Geneva font (uppercase) and presented in the centre of a 14 inch PC screen. The background was black, the names appeared in white.

Apparatus and Procedure Instructions were presented on the PC screen and emphasised the importance of speed and accuracy. Participants were asked to *read each name as quickly and accurately as possible.* Names were displayed individually in uppercase Geneva font, in the centre of a 14 inch PC screen. Name reading latency was measured using a voice key connected to the port of the PC. The onset of the participants' vocal response was detected by use of a throat microphone.

A "*" fixation point began each trial until participants indicated readiness to continue by tapping the desk. Stimulus presentation was initiated by the experimenter. Each trial commenced with a 250 msec. tone and followed by 250 msec. interval before the stimulus appeared. Participants read each name aloud. The vocal response triggered the voice key and terminated the display of the name. The reading latency was logged by the computer. The experimenter accepted only correct full names for data analysis by entering a code on the keyboard.

The reading task took about 15 minutes after which participants performed the rating tasks. As in the previous experiments faces were presented to collect the *post hoc* ratings to confirm the initial selection of items based on matched rated familiarity, distinctiveness and AoA. An advantage of using faces to collect ratings is that it ensures that confusion did not occur where two personalities form part of a double act, (e.g. Vic

Reeves and Bob Mortimer who work as a comedy team). However, in this experiment names rather than faces of the celebrities served as stimuli. Therefore, the question is raised as to whether matching based on faces would be reliable for the celebrities' names. This issue is addressed in Experiment 9 where *post hoc* ratings were made to printed names. At this point, it is merely noted that the rating data collected in Experiment 9 showed that the early and late acquired sets of stimuli were also matched on ratings collected from names. Table 5. 1 shows the *a priori* ratings and mean attributes on the other independent variables:-

Table 5. 1: The mean rating and attribute scores for stimulus sets.

Age of Acquisition	Fam.	Dist.	AoA	Frequ.	Pheme	Nme L
Early	**5.85** n.s.	**3.81** n.s.	**4.51*****	**1.32** n.s.	**9.76** n.s.	**11.84** ns
s.d.	0.63	1.00	0.61	0.89	1.36	1.60
Late	**5.65**	**3.35**	**6.05**	**1.14**	**9.88**	**11.80**
s.d.	0.41	0.86	0.34	0.88	2.24	2.78

Key: Fam = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log surname frequency (x+1): Pheme = The number of phonemes in the full name, NmeL = full name letter length, *** = $p<.0001$: n.s. = $p>.1$

Table 5.1 also shows that the stimulus sets were also matched on the number of phonemes in the full name, on surname frequency and the number of letters in the celebrities' full names (individual letter length data appear in Appendix 5.4.iv). The only statistical difference between the two groups occurred for AoA.

Table 5. 2: The initial pronunciation for Christian names

Pronunciation	Age of Acquisition	
	Early	Late
Voiced	9	9
Africative Voiced	4	6
Plosive Voiced	4	2
Unvoiced	5	4
Plosive Unvoiced	3	4

Table 5. 2 shows that the phonemic energy of the initial letters of celebrities' Christian names were closely matched. However, Brown and Watson (1987) report that the effect of initial phoneme energy value on word naming speed did not supersede the effect of AoA in a word naming task. Also Valentine and Moore (1995) report studies to show that phoneme energy does not affect the reaction times of producing celebrities' surnames. They argue that the typically long reaction times evinced for the production of people's names obscure any minute differences created by the pronunciation power of initial phonemes. After taking part in Experiment 7 the participants were debriefed.

5.2.ii Results.

A total of 92 errors were removed from the data. The mean reading latencies and accuracy of response for the remaining correct responses were calculated for analysis. The mean reading time was 563 msec (s.d. = 117 msec.). The mean number correct response was 23.08 (s.d. = 1.98) out of a maximum of 25.

A one way analysis of variance showed a significant effect of AoA on participants' reading speed between early (mean = 551 msec., s.d. = 111 msec.) and late acquired celebrities' names (mean = 575 msec., s.d. = 123 msec.), $F_1(1,23) = 8.26$, $p<.01$. The items analysis approached significance ($t_2(2,48) = 1.44$, $p = .08$). Participants were faster to read celebrities' names rated as acquired early in life than they were to read late acquired celebrities' names.

As anticipated by the ease of the task no significant difference was observed in a similar analysis of the accuracy to produce early acquired (mean = 23.13, s.d. = 2.00) and late acquired celebrities' names (mean = 23.04, s.d. = 2.00); F_1 and $t_2 < 1$.

Item Reliability Measures: Data from participants' ratings were analysed by unrelated *t* tests and as shown in Table 5. 3 the results confirmed validity for the selection of stimulus sets.

Table 5. 3: Mean *post hoc* rating scores from Experiment 7.

	Age of Acquisition Early	Late	Difference
Familiarity	**5.77** (.54)	**5.71** (.40)	n.s.
Distinctiveness	**3.81** (1.00)	**3.35** (.86)	n.s.
Age of Acquisition	**4.48** (.66)	**6.06** (.35)	$t(2,48)=10.82, p<.0001$

Difference = the statistical differences between the two groups.

5.2.iii Discussion

Participants were faster to read celebrities' names rated as acquired early in life than they were to read late acquired celebrities' names. This result is consistent with a locus proposed for the effects of AoA at the level of the speech output system and is analogous to the effect found on latencies for reading words aloud (e.g. Gerhand & Barry, 1998).

EXPERIMENT 8
FAMILIARITY DECISIONS TO PRINTED NAMES

5.3.i Introduction.

Lexical decisions are faster to early acquired words than to late acquired words (Morrison & Ellis, 1995; Gerhand & Barry, in press). Face familiarity decision latencies were faster to celebrities rated as early acquired than to celebrities rated as late acquired. Experiment 8 investigates the effect of AoA when name familiarity decisions are made. The experiment was similar to Experiment 5 in Chapter 4, with the names of celebrities replacing their faces as stimuli.

5.3.ii Method

Participants: There were 24 (12 male, 12 female) participants in this experiment (mean age 19.38 years, s.d. = 1.44), they were paid £2 for their participation.

Materials and Apparatus: The 50 printed celebrities's names described as critical items in Experiment 7 were also employed here. Fifty unfamiliar names were included as filler items (e.g. Andrew Poole, Tony Walsh). The names were presented on the computer screen, as described in Experiment 7.

Design: This was a within-participants one factor design with two levels of AoA (early vs. late). Response latencies and the accuracy of correct response were the dependent variables.

Procedure: One hundred printed names were presented individually in the centre of the screen. Participants were asked to *decide as quickly and accurately as possible whether or not each name was that of a famous person.* They should press the "YES" button of a hand-held response box for a famous person and the "NO" button for a name they did not recognise. The task took approximately 5 minutes to perform and was followed by the participants rating the celebrities' faces for familiarity, distinctiveness and AoA. Finally participants were debriefed.

5.3.iii Results

A total of 91 errors were removed from the data. The mean reaction time of the remaining correct familiarity decisions made to the 50 celebrities' names and the mean number of correct responses were calculated. The mean reaction time was 646 msecs. (s.d. = 100 msecs.). The mean number of correct response was 23.10 (s.d. = 1.80) out of a maximum of 25.

A one-way analysis of variance showed there was a highly significant effect of AoA in participants' latencies of correct responses between early (mean = 630 msecs., s.d. = 100 msecs.) and late acquired celebrities' names (mean = 662 msecs., s.d. = 100 msecs), $F_1(1,23)=11.15$, $p<.003$. The items analysis was not significant ($t_2(2,48)=1.39$, $p = .09$). Participants were faster to make a familiarity decision to famous names rated as early acquired than to late acquired celebrities' names.

A similar analysis showed a significant difference in participants' data between the accuracy of early acquired (mean = 23.58, s.d. = 1.53) and late acquired celebrities' names (mean = 22.63, s.d. = 1.95) $F_1(1,23)=9.57$; $p<.005$. The items was not significant ($t_2(2,48)=1.16$, $p<.12$).

Item Reliability Measures: Data from participants' ratings were analysed by unrelated *t* tests and are shown in Table 5. 4. These results confirm the validity for the selection of stimulus sets, i.e. the *post hoc* ratings differed significantly in measures of AoA but not in measures of familiarity or distinctiveness.

Table 5. 4: Mean *post hoc* ratings from Experiment 8.

	Age of Acquisition		
	Early	**Late**	**Difference**
Familiarity	**5.85** (.54)	**5.65** (.41)	n.s.
Distinctiveness	**3.81** (1.00)	**3.35** (.86)	n.s.
Age of Acquisition	**4.51** (.61)	**6.05** (.36)	**$t(2,48)=8.99$, $p<.001$**

Difference = the statistical differences between the two groups. n.s. = $p>.1$

5.3.iv Discussion

Familiarity decisions made to early acquired celebrities' names were significantly faster and more accurate than those made to the names of late acquired celebrities. The advantage for early acquired names in a name familiarity decision task is analogous to the effect of AoA found in a face familiarity decision task (Experiment 5) and a lexical decision task (Morrison & Ellis, 1995; Gerhand & Barry, in press).

EXPERIMENT 9

SEMANTIC CLASSIFICATION TO PRINTED NAMES.

5.4.i Introduction

Morrison *et al.* (1992) found no effect of AoA when semantic decisions were made to pictures of objects. In Experiment 6, there was a significant advantage for *late* acquired classification latencies when participants decided whether celebrities hosted 'chat-type' shows. In Experiment 9, the same semantic decision is used to investigate the effect of AoA on classifications to the printed names for the same 50 celebrities. It was proposed in Experiment 6 that the speed advantage for late acquired celebrities was due to an automatic activation of the PIN - lemma link. Furthermore, this automatic activation of the PIN - lemma link delayed access to the semantic system. If this were the case, then one would not predict any effect of AoA in a task where participants are provided with the name, this will be tested in Experiment 9. By analogy no effect of AoA is predicted, there is no *a priori* theoretical reason to predict the advantage for late acquired items that was observed in Experiment 6.

So far the *post hoc* ratings from each experiment have supported the validity of the stimulus sets. Significant differences between early and late AoA ratings were confirmed, and no significant differences between ratings of familiarity or distinctiveness have been observed. Therefore, the AoA groups were valid for participants from each experiment reported. However, Experiments 7, 8 and 9 employ the names of celebrities rather than their faces in the experimental tasks. It has been assumed that the ratings of AoA and familiarity collected from the faces of celebrities would be similar to those collected from names. Ratings in Experiment 9 addressed this issue by requiring participants to rate printed names for comparison with the *a priori* data collected from faces (used to construct the initial stimulus sets). Rated facial distinctiveness was not applicable to names and therefore this task was omitted.

5.4.ii Method

Participants: There were 24 participants (11 male, 13 female) in this experiment their mean age was 19.5 years (s.d. = 1.25), they were paid £2 for their participation.

Materials and apparatus: The printed names of the celebrities used in Experiment 6 were employed here, 50 were the critical items and 50 were the filler celebrities. Filler items were matched in occupation only (a list of 'filler' celebrities appears in Appendix 4.2.iv). Instructions were identical to Experiment 6, with the word 'name' replacing the word 'face' where applicable. Participants decided whether or not each celebrity name was famous for appearing in, or hosting 'chat-type-shows'. The apparatus was the same as described for previous experiments.

Design: This was a within-participants one factor design with two levels of AoA (early vs. late). Decision latency and accuracy of response were the dependent variables.

Procedure: The printed names were presented as described for Experiment 7 and 8. Participants responded by pushing a button on the hand-held response box. Their response stopped the timer and removed the name from the screen. The instructions were identical to Experiment 6 (reworded only to accommodate the word 'name' instead of 'face' where required) with the same emphasis placed on the need for speed and accuracy. The occupation classification task took approximately 10 minutes and was followed by rating printed names. Participants rated the 50 critical celebrities' names for familiarity and AoA. The rating scales and instructions were identical to those described above for collecting ratings of faces. This task took about 15 minutes. Finally participants were debriefed.

5.4.iii Results

A total of 256 errors were removed from the reaction time data. The mean latency and accuracy of correct responses to celebrities' names were calculated. The mean classification time was 856 msec. (s.d. = 240 msec.). The mean number of correct response was 19.67 (s.d. = 3.65) out of a maximum of 25.

The difference between latencies to classify early acquired (mean = 851 msecs., s.d. = 221 msec.) and late acquired (mean = 861 msecs., s.d. = 263 msec.) celebrities' names was not significant by participants' (F_1) or by items (t_2 <.5) The unrelated t test was significant The difference in the accuracy data was also not significant between early (mean = 19.54, s.d. = 4.00) and late acquired (mean = 19.79, s.d. = 4.00) celebrities' names, (F_1 and $t_2 < 1$).

Table 5.5: Mean Scores of Overall Face Rating Scores and Ratings Scores to Printed Names in Experiment 9

	FACE	NAME	
	A Priori Ratings	*Post Hoc* Ratings	Face vs Name Difference
FAMILIARITY			
EARLY AoA	**5.85** (.63)	**5.68** (.50)	t(2,48)=.94, p<.18
LATE AoA	**5.65** (.41)	**5.81** (.59)	t(2,48)=1.22, p<.12
Early vs Late Difference.	t(2,48)=1.18, p<.25	t(2,48)=0.42, p<.68	
AGE OF ACQUISITION			
EARLY AoA	**4.51** (.61)	**4.43** (.58)	t(2,48)= .37, p<.36
LATE AoA	**6.05** (.36)	**6.01** (.35)	t(2,48)=.43, p<.34
Early vs Late Difference.	**t(2,48)=10.30, p<.0001**	**t(2,48)=7.02, p<.0001**	

Key: AoA = Age of acquisition, Standard deviations are shown in parentheses,

Difference = the statistical differences between the two groups.

Item Reliability Measures: The mean AoA and familiarity ratings were calculated for each celebrity (the mean scores derived appear in Appendix 5.4.iv). The *a priori* rating scores (made to celebrities' faces) are shown in Table 5.5. The mean *post hoc* rating scores of printed celebrities' names were analysed using unrelated *t* tests and confirmed the validity for the selection of stimulus sets. There was a highly significant difference in the ratings of AoA between the experimental groups, with no difference of familiarity. It is also shown in Table 5.5 that no significant differences occurred between the ratings of familiarity or between ratings of AoA for faces and for names.

5.4.iv Discussion

No effect of AoA occurred when participants made classifications to the written names of celebrities. In Experiment 6 participants were faster to make the same classifications to celebrities' faces rated as *late* acquired. In this Experiment the same celebrities and categorisation task were used as in Experiment 6 but there was no advantage for early or late acquired celebrities' names. Morrison *et al.* (1992) found no effect of AoA on the reaction time required to classify objects as man-made vs. natural. The most parsimonious interpretation of these results is that there is no effect of AoA in semantic classification tasks. The significant advantage for classification of late acquired faces in Experiment 6 could have been due to chance or an artefact of the demands of the task and will be discussed more fully in Chapter 6 (Section 6.3.iv).

Experiments 6 and 9 investigated how AoA would affect the classification of celebrities' faces and names according to identity-specific semantic information. It was important to employ the same stimuli where the effects of AoA had been established for face naming. The selection of celebrities in the early and late AoA groups did not break down into more "common" semantic categories (Barsalou, 1983), for example, male or female; alive or dead, etc. The *occupational* categorisation task required participants to decide whether or not celebrities were famous for hosting 'chat-type-shows'. This was the only way in which the groups could be equally divided and therefore it was justified as an initial exploration. The classification task may be considered to be an "*ad hoc* category" (Barsalou, 1983) and therefore the advantage in classifying late acquired celebrities (Experiment 6) should be viewed with caution. The semantic classification paradigm could be improved with the addition of an item-specific classification choice. For example, presenting the instructions before each item (e.g. 'decide whether or not this face belongs to a politician'; 'decide whether or not this face belongs to an actor'). The task should require the same response (e.g. 'Yes') for all the critical items.

5.5 General Discussion.

The aim of Chapter 5 was to investigate the locus of AoA in famous name processing tasks. Experiment 7 established that an effect of AoA was apparent when participants read celebrities' names aloud, this result is analogous to the effect found on latencies for reading words aloud (e.g. Gerhand & Barry, 1998). The finding of Experiment 7 is entirely consistent with a locus for AoA at the level of the phonological output lexicon.

Familiarity decisions made to early acquired celebrities' names were significantly faster and more accurate than those made to the names of late acquired celebrities (Experiment 8). The advantage for early acquired names in the name familiarity decision task is analogous to the effect of AoA found in a face familiarity decision task (Experiment 5) and a lexical decision task (Morrison & Ellis, 1995; Gerhand & Barry, in press).

There was no effect of AoA when participants made semantic classifications to celebrities' printed names in Experiment 9. Therefore, the results of the two experiments requiring a decision based on identity-specific semantic information to faces (Experiment 6) and printed names (Experiment 9) did not show the same pattern of results. Participants were significantly faster to decide the occupational category of celebrities' faces rated as *late* acquired in Experiment 6. However, there was no such advantage for the same decision to printed names in Experiment 9. It is possible that investigating identity-specific semantics using the somewhat awkward classification task 'chat-show-host' may not have been the best method to investigate the effects of AoA on identity-specific semantic information. A fuller discussion of this issue is presented in Chapter 6 (Section 6.3.iv).

The experiments presented in the previous chapters of this thesis were based on ratings made to the faces of celebrities. The *post hoc* ratings from each experiment have supported the validity of the stimulus sets. That is to say, significant differences occurred between early and late AoA ratings with no differences between the ratings of familiarity or distinctiveness. However, Experiments 7, 8 and 9 employed celebrities' printed names as experimental stimuli, rather than their faces. Ratings collected from participants in Experiment 9 were made to the celebrities' printed names. The *a priori* data collected from celebrities' faces (used to select the stimulus sets) and the *post hoc* ratings made to the printed names confirmed the validity and reliability of the selected stimulus sets.

CHAPTER 6: SUMMARY, DISCUSSION AND CONCLUSIONS.

6.1 Introduction

The results of the nine experiments reported in this thesis are summarised below. The summary is followed by a discussion of the results and their implications for general mechanisms and the locus for the effects of AoA. A number of problems are identified and discussed, together with some statistical issues. A number of topics in the literature are then discussed in light of the reported findings; in particular the effects of AoA in the domain of person processing and the relationship between object, word and face naming models. Suggestions for further research are made where appropriate.

6.2 Summary of experimental results.

Previous research has shown that, when naming pictures, reading aloud printed words, or making lexical decisions to printed or spoken words, early acquired items are processed more quickly than are late acquired items (e.g. Morrison *et al.,* 1992; Gerhand & Barry, 1998; Turner *et al.,* in press). The experiments reported in this thesis have extended this work by establishing that an effect of AoA is also apparent in processing celebrities' faces and names that do not require access to identity-specific semantics.

The effects attributed to word frequency and AoA on picture naming, lexical decisions and word reading were described in Chapter 1. It was shown that word frequency and AoA are highly correlated in word and picture processing experiments. There were no *a priori* theoretical reasons to suppose that surname frequency and AoA would correlate when famous people were used as stimuli. Therefore, processing of celebrities' faces and names appeared to be a promising vehicle to tease the effects of these two variables apart. The first study of this thesis investigated which variables influenced face naming. The variables investigated were familiarity with celebrities;

distinctiveness of celebrities' faces; the age of acquiring knowledge of celebrities; the frequency of celebrities' surnames in the general population and the number of phonemes in the full name. In Experiment 1, participants rated and then attempted to name celebrities' faces. A multiple regression analysis revealed that rated familiarity was the most influential variable for predicting the speed and accuracy of naming celebrities' faces. Rated familiarity was considered to be synonymous with the frequency of encountering a celebrity over a lifetime (or cumulative frequency). The only other variable to significantly enter the regression equation and predict the speed and accuracy of naming celebrities' faces was AoA.

In an object naming study Barry *et al.* (1997) found an interaction between spoken word frequency and AoA such that AoA did not affect the latency to produce high frequency names, but did affect the time to produce low frequency names. By analogy, these findings suggest that no effects of AoA would be apparent for celebrities rated as highly familiar. Experiments 2 to 4 report factorial manipulations of AoA in face naming tasks (where all of the other variables were matched). Face naming is a difficult task, obviously participants would only be able to name celebrities with whom they were familiar. Therefore, celebrities of both early and late AoA were selected on the basis of high familiarity (or cumulative frequency). The results showed that the faces of celebrities rated as acquired early in life were named faster than were the faces of celebrities rated as acquired later in life. Furthermore, this effect was robust even though the sets of items were matched on ratings of familiarity.

Experiments 5 and 6 are reported in Chapter 4. Experiment 5 reports a familiarity decision task where participants were faster to recognise celebrities' faces rated as early acquired than they were to recognise faces rated as acquired late in life. Experiment 6 reports a semantic classification task. Participants decided whether or not the faces presented were of celebrities who were famous for hosting a 'chat-type-show'. Participants were faster to make this decision to celebrities' faces rated as *late* acquired than to celebrities rated as early acquired. Both of these experiments required participants to respond by a button push, made on a hand-held response box. These experiments reveal that speech production was not required for an effect of AoA.

The experiments reported in Chapter 5 extend the previous studies by using celebrities' printed names as experimental stimuli. Participants were required to read aloud the printed names of celebrities' in Experiment 7. The results showed that participants were faster to read the printed names of early acquired celebrities than they were to read the names of late acquired celebrities. This result is analogous to the effect of AoA observed on the latency required to read aloud printed words (e.g. Morrison & Ellis, 1995; Gerhand & Barry, 1998).

Participants performed a familiarity decision task to printed names in Experiment 8. Participants were faster to recognise early acquired celebrities' names than they were to recognise late acquired names. This effect may be seen as analogous to the effect of AoA in the lexical decision task (Morrison & Ellis, 1995; Gerhand & Barry, in press).

Experiment 6 reports a significant advantage for participants to classify late acquired celebrities' faces in terms of an occupational category. However, this effect was not apparent when the same task was performed to printed names (Experiment 9). When participants classified the names of celebrities' for whether or not they hosted a 'chat-type-show' there was no effect of AoA (Experiment 9). Thus, there was no advantage for early acquired celebrities when participants made occupational decisions to either celebrities' faces (Experiment 6) or to their printed names (Experiment 9). It is possible that the advantage for classifying the faces of late acquired celebrities in Experiment 6 was attributable to chance or that it is an artefact of the category decision being computed "on-line" (Bruce, Carson, Burton, & Ellis, 1998). However, what is clear, is that the semantic classification (requiring access to identity-specific semantic information) was not made more quickly to early acquired items. This result is analogous to Morrison *et al.'s* (1992) finding that there was no effect of AoA on a semantic classification of objects.

The effects of AoA have been established for lexical processing and object naming. As models of face processing developed by analogy to word and object processing models it was pertinent to investigate whether AoA would affect person naming and recognition. The experiments reported in this thesis have established that robust effects of AoA do occur for face naming and recognition. There are also effects of AoA apparent in tasks to the printed names of celebrities, (e.g. reading and recognition). The effects of AoA in processing people's names and faces contribute to the research on AoA in two ways. First, the effects of AoA on a face familiarity decision challenge the idea of a single locus (in the phonological output lexicon) being responsible for the effects of AoA. Second, the effects of AoA in people processing must challenge the developmental mechanism proposed in the completeness hypothesis (Brown & Watson, 1987) as the sole basis of an effect of AoA. This is because the effect of AoA for early acquired celebrities was established for items acquired between the ages of 6 and 12 years. Whereas, many of the measures of AoA for lexical and object processing studies report early items as acquired up to the age of 6 years.

6.3 Methodological issues.

The nine experiments reported in this thesis establish that the AoA of celebrities influences the later processing speeds on cognitive tasks, that do not require access to identity-specific semantics. Therefore, these results present problems for the established locus and mechanism proposed to account for the effect of AoA in lexical and object processing (e.g. Brown & Watson, 1987).

The experiments reported here represent an initial investigation, and require replication and further studies to establish the level of the effect of AoA in person processing. There are a number of ways that the problems encountered can inform the design of future studies. Some such problems are discussed below, beginning with the importance of collecting ratings from experimental participants. This is followed by highlighting some issues pertaining to the use of celebrities as experimental stimuli, together with the problem of young participants. Methods for rectifying these problems are suggested. There was a high proportion of face naming errors in the first three experiments and practising name production in Experiment 4 did significantly reduce the errors, however, the speed of name production was reduced to a base line where the effect of AoA disappeared.

A discussion over the difficulty of developing a scale for the recency of encountering a celebrity (Appendix 2.4.2) is followed by a critical review of the semantic classification task employed for Experiments 6 and 9, because it was rather a contrived task. A change in the experimental task may circumvent this problem. Finally, statistical issues and especially the lack of consistent significant results in the items analyses is addressed.

6.3.i Ratings of age of acquisition.

Morrison *et al.* (in press) investigated cumulative frequency and residence time in memory in three experiments with young and older adult participants. The measures of AoA were taken from normative data on children's naming (Morrison et *al.*, 1997) rather than on adult estimates of AoA. The results showed that naming speeds were progressively slower as age increased, although all groups did show an effect of AoA. The oldest group of participants made a large proportion of misnaming 'errors' (e.g. 'keg' to the picture of a barrel and 'fiddle' to the picture of a violin). It is entirely possible to interpret such 'errors' in terms of AoA, because both 'keg' and 'fiddle' describe the pictures depicted in the line drawings. Furthermore, it is possible that such names would have been in common usage when the older participants were young. This study highlights the importance of collecting separate AoA ratings from the people participating in the experimental tasks. In all of the experiments in this thesis the ratings from the participants involved in each task are reported.

6.3.ii Celebrities as stimuli.

Face naming is an error prone and difficult task to perform and is one of the most spontaneously reported memory problems (Burke *et al.*, 1991; Brédart, 1996). It is accepted that naming faces under every day circumstance is difficult, and therefore one would anticipate naming famous faces under experimental conditions to exacerbate the difficulty of this task (especially with the use of a throat microphone to collect naming latencies). Not surprisingly, the error rate for face naming was very high (e.g. 43% in Experiment 1). The hope that naming practice would improve the error rate (and possibly the variation in naming latencies) in Experiment 4 was worthy of investigation, and did significantly reduce the error rate. However, the naming practice served to diminish the effect of AoA in the naming latency data (see Table 6.1).

Testing participants on difficult tasks requires the experimenter to ensure that the ethics of psychological experimentation are not overlooked. It is important to alleviate the stress of participants' negative feelings that they are "not very good at this". Therefore time was given to encourage and reassure participants for all the experiments reported in this thesis. The debriefing sessions included the use of individual and group data to explain the contribution of their participation to the research in this area. Following debriefing, participants were asked if they had any comments concerning the experiment. Many participants made different points concerning individual celebrities, for whom they had a preference or personal dislike. It transpired that some participants had posters, etc. of celebrities on their walls, or had seen a video of a particular celebrity the night before the experiment. Therefore, the inclusion of a measure for recency of encounter appears to be a necessary control for future experiments using celebrities as stimuli.

6.3.iii Recency of encounter

An attempt to control for how recently a celebrity had been in participants' personal domain (Pilot study 2, Appendix 2.4.2) was not successful. Evidence in support of recency as an influential variable may be drawn from priming studies (e.g. Bruce & Valentine, 1985). Such studies report that repetition priming has robust and long lasting effects on subsequent processing speeds. That is to say the previous exposure to a celebrity would have an implicit effect on participants' memory and influence participants' performance on the current experimental task.

The recency rating scale created for Pilot study 2 was designed to be analogous to the scales used for familiarity, distinctiveness and AoA. However, future research would be advised to create a wider measurement that should encompass participants personal preferences in the scale. Therefore, the method of assessing how recently a celebrity was last encountered would need to include a measure for participants' personal favourites (e.g. whether or not participants had a poster of the celebrity, etc.)

6.3.iv The type of classification task

Experiments 6 and 9 investigated how AoA would affect the classification of celebrities' faces and names according to identity-specific semantic information. The task chosen was rather contrived, but it was important to employ the same stimuli where the effects of AoA had been established for face naming. The selection of celebrities in the early and late AoA groups did not break down into more "common" semantic categories (Barsalou, 1983), for example, male or female; alive or dead, etc. The *occupational* categorisation task required participants to decide whether or not celebrities were famous for hosting 'chat-type-shows'. This was the only way in which the groups could be equally divided and therefore the occupation-type category was justified as an initial exploration. The classification task may be considered to be an "*ad hoc* category" (Barsalou, 1983) and therefore the advantage in classifying late acquired celebrities (Experiment 6) should be viewed with caution. The semantic classification paradigm could be improved with the addition of an item specific occupation choice. For example, instructions would appear before presenting each item (e.g. 'decide whether or not this face belongs to a politician'; 'decide whether or not this face belongs to an actor'). The task should require the same response (e.g. 'Yes') for all the critical items.

6.3.v Statistical issues.

A problem with some of the effects of AoA reported in this thesis lies with the lack of statistical significance for the items analyses (see Table 6.1). One of the reasons for this rests with the method of dividing the stimuli into the two experimental groups. The ratings of AoA for the two groups were divided on a median split, on the basis that the median was the 50th percentile of measures, not a defined point on the distribution of numbers, (as shown in Chapter 3, Figure 3.1). The method of dividing the AoA ratings into two groups, (with the highest early mean rating score = 5.45 just below the lowest late mean rating score = 5.51) required that the experiments were designed for the analyses to take participants as the random factor. It is important to remember that the within-participants analyses have more statistical power than the between-items analyses. This is because within-participants analyses will serve to control for individual differences in performance. The between-items analyses would include variation between participants in addition to variance due to the items in the error term.

The data often had distributions with large values in positive tails (e.g. reaction times above 2.5 seconds). The reciprocal transformations reduced the influence of such extreme outliers. In this way the outliers have considerably less effect on the size of the standard deviations than was the case prior to the transformations. Therefore, the reaction time data for both participants and items were subjected to reciprocal transformation to correct skews in the data as prescribed by standard statistical texts (e.g. Howell, 1992). The use of reciprocal transformations also has the benefit of retaining the transformed figure as a meaningful quantity (i.e. the reciprocal of naming latencies becomes 'naming speed').

As described above naming faces can be a difficult and error prone task, with tip of the tongue states or hesitations of response not infrequent. Because of this, authors often remove reaction times that lie above or below two (or two and a half) standard deviations from the mean, in order to avoid very long latencies of a few correct responses (e.g. Valentine *et al.*, 1995). The problem with removing outliers in this way, is that the data has been deliberately manipulated in such a way that it is no longer independent (Wilcox, 1998).

One appropriate method of dealing with outliers is 'data trimming' (e.g. Howell, 1992; Wilcox, 1998). Trimming serves to eliminate genuine outliers by removing a fixed percentage of the data from the lowest and highest data-points. For example, an interquartile range is obtained by discarding the upper and lower twenty-five per cent of the overall distribution and taking the range of the remaining fifty per cent of observations. An improved experimental design could incorporate the use of data trimming and should accommodate this by using larger stimulus sets for group manipulation. Alternatively, it may be possible to use 'Winsorized' samples as a potential solution. 'Winsorized' samples refer to trimming the data, as above, but replacing the removed values with the most extreme values remaining in each tail. This would also require manipulating the degrees of freedom for the proportion of 'Winsorized' values (Wilcox, 1998). However, as previously discussed (Chapter 2, Section 2.4.i) a high proportion of errors are common in face naming tasks, and because of this replacing data in the manner prescribed for 'Winsorized' data should be performed with caution.

Table 6.1 shows the mean participants' data for all the experiments together with the significance levels of the within-participants and between-items analyses. It is immediately obvious that replacing the analyses of variance with one-tailed *t* tests would coax some, but by no means all, items analyses into significance (i.e. those with $p<.10$). This could be justified on the grounds that items were manipulated into defined groups of AoA, and the effect of AoA was established in Experiment 1. However, non-significant items analyses do remain problematic, and while it may be attractive to transform and analyse data until a significant result is obtained, the method of analyses was decided *a priori* and the results reported have adhered to those methods. Future studies may circumvent this problem by including one of the methods of data treatment referred to above and by incorporating other changes in design, especially in terms of the participants' age range.

Table 6 also reveals the lack of reliability for the items' analysis for the experiments where printed names were employed as stimuli. It would be unwise therefore to interpret these results in the same light as the robust advantage established where faces were presented as stimuli.

Table 6.1:

Mean scores and significance levels taking participants and items as the random factor.

Exp	Task	Early AoA	S.D.	Late AoA	S.D.	Within Participant	Between items
1	Name		1384 (206) millisecs			n.a.	Sr^2 =.08
2	"	1292	236	1446	257	p<.001	p<.01
3	"	1310	314	1545	426	p<.0001	p<.01
4	" Block 1	1526	305	1630	304	p<.04	p<.05
	2	1219	214	1334	249	p<.01	p<.05
	3	1116	221	1205	263	p<.05	p<.05
	4	1073	208	1143	234	p<.08	p<.09
5	FDT	642	86	682	76	p<.0001	p<.05
6	Semantic	920	285	875	239	p<.03	p<.04
7	Read	551	111	575	123	p<.01	p<.08
8	FDT	630	100	662	100	p<.01	p<.09
9	Semantic	851	221	861	263	p<.70	p<.50

Exp	Task	Early AoA	S.D.	Late AoA	S.D.	Within Participant	Between items
1	Name		17.80 (5.92)			n.a.	Sr^2 =.09
2	"	17.77	4.31	18.20	4.69	p<.001	p<.01
3	"	17.67	3.73	15.96	4.14	p<.01	p<.10
4	" Block 1	13.71	4.95	11.83	4.36	p<.01	p<.05
	2	18.58	3.50	18.08	3.49	p<.10	p<.05
	3	20.88	2.72	19.79	3.74	p<.10	p<.05
	4	21.75	2.35	21.33	2.46	p<.10	p<.05
5	FDT	22.67	2.00	22.12	2.00	p<.30	p<.30
6	Semantic	21.50	1.77	21.71	2.20	p< 1.0	p<.42
7	Read	23.13	2.00	23.04	2.00	p<.90	p<.40
8	FDT	23.58	1.53	22.63	1.95	p<.005	p<.12
9	Semantic	19.54	4.00	19.79	4.00	p<.60	p<.40

Key: Exp = Experiment; Task: Name = name celebrity face, FDT = familiarity decision task, Semantic = classifications; Read = read printed names; Mean RT = the mean reaction time for all correct responses (participants data); S.D. = standard deviations; Within = the results of one-way within-participants ANOVA; Between = the results of unrelated t test; n.a. = not applicable; Sr^2 = the semipartial regression coefficient; Mean Accuracy = the mean number of correct responses (participants' data).

6.3.vi The age of the participant population.

The experiments reported here represent an initial exploration into the effects of AoA on person processing. A different design could improve the data for future investigations. Future studies could recruit an older population of participants, thereby allowing for a wider field of stimuli. With older participants it would be possible to select celebrities from quite distinct time periods. For example, groups of celebrities that were famous during participants' youth that are no longer in the public eye; celebrities that were famous during participants' youth and remain in the public eye and celebrities that are have become famous over the past ten or twenty years. By recruiting older participants a significant margin between the groups of AoA ratings could be maintained. Also older people should have acquired knowledge of a larger selection of celebrities from the different circumscribed periods. The method of generating stimuli described above should provide large numbers of celebrities in clearly defined groups, with a gap of ten years or so between the groups. This was not possible for participants in the experiments reported here.

The recruitment of older participants was not a viable option for the experiments reported in this thesis. The difficulty in identifying groups of celebrities with replicable ratings was discussed in Chapters 2, 3 and the Pilot Studies reported in the Appendices. Once the sets of items were established to have replicable ratings, and for which an effect of AoA in face naming paradigms was established, it would not have benefited the results to test older groups of participants on the different tasks. It would also be untenable to expect the AoA ratings generated by young participants to generalise to older participants. Also some celebrities that would be early acquired for older participants (e.g. Clint Eastwood) were rated as acquired late in life by young participants.

6.4 The relationship between word, object and face recognition and naming.

Models of face recognition and naming were developed by analogy to models of word and object recognition and naming. Therefore, finding that AoA affects the speed and accuracy of word and object naming raised the question of whether AoA would also affect the speed and accuracy of naming people's faces. The experiments reported in this thesis have demonstrated a robust advantage in speed of name production for early acquired celebrities in both multiple regression and factorial paradigms. Participants evinced a facilitation in speed and accuracy when producing celebrities' names rated as acquired early in life, both with and without prior presentation of the face. The reported effect of AoA on proper name production has implications for the mechanism and locus proposed to account for the effects of AoA on lexical and object processing.

In the account of AoA proposed by Brown and Watson (1987), the mechanism of the effects of AoA occurred during a developmental stage in vocabulary acquisition. This was proposed to cause functionally different storage mechanisms for early and late acquired words and object names. Early acquired words would be stored as a more complete phonological representation than words acquired later in life. Late acquired words would have only minimal information stored explicitly. Because of this late acquired words would require reassembling before production, causing longer production times than required for early acquired words. According to the completeness hypothesis this mechanism has the primary locus at the level of phonological representations.

6.5 The locus of the effects of age of acquisition.

Brown and Watson (1987) proposed a developmental mechanism with a single locus for the effect of AoA at the level of speech output. This argument is consistent with the model of concept representation proposed by Rosch, Mervis, Gray, Johnson and Boyes-Braem (1976). However, Rosch *et al.* propose that a semantic basic level of categorisation would also exist, and that the first learned exemplar of a category would be the best remembered and the most easily named of that category. Rosch *et al.* asked 'Why should anyone say "fruit" instead of the first learned "apple"?'

A single locus for the effects of AoA and the fixed developmental mechanism is supported by Morrison *et al.*, (1992; Morrison & Ellis, 1995; Morrison *et al* in press) but not by Gilhooly and Gilhooly (1979). Gilhooly and Gilhooly (1979) argued that early acquired words are used to learn late acquired words, therefore early words receive implicit activation whenever late acquired words are used. Barry *et al.* (1997) propose a locus at the level of the lexeme (after lemma selection and activation of the lemma-lexeme link), this locus refines the phonological output lexicon as the primary locus for the effects of AoA.

The effect of AoA on lexical decision has been attributed to automatic activation of the representation of phonology at the level of the speech output lexicon (Morrison & Ellis, 1995; Gerhand & Barry, in press). However, Yamazaki *et al.* (1997) report effects of AoA for spoken words and written Kanji characters in Japanese participants. The Japanese junior education system requires children to be taught specific Kanji characters at specific ages, therefore the characters defining certain words can be age-marked with precision making the AoA for spoken words and written Kanji characters quite distinct. Yamazaki *et al.* interpret the effects on spoken and written AoA as evidence for a second locus of AoA, which they place at the level of the visual input lexicon. Turner *et al.* (in press) found an effect of AoA on lexical decision to spoken words. However, it could be argued that a single phonological lexicon mediates spoken word recognition and speech production..

The effect of AoA on the latency to read aloud famous names (Experiment 7) could be due to a locus of AoA at the phonological output lexicon. The effect of AoA on recognition latencies in the name familiarity decision in Experiment 8, could possibly be attributed to automatic activation of phonological representations of familiar names. However, Experiment 5 shows that a single locus for all the effects of AoA can no longer be maintained. The effect of AoA on a face familiarity decision requires a locus of AoA in face processing at or before the level of person identity nodes (PINs) because the familiarity decision is assumed to be based on activity of the PINs (Burton *et al.,* 1990). It is implausible that phonological information is automatically activated by a familiar face. Valentine *et al.* (in press) have shown that naming a famous face primes a familiarity decision to the name of the same celebrity, however, a prior face familiarity decision produced no such facilitation. This result demonstrates that face familiarity decision does not automatically activate a phonological representation for celebrities' names. This conclusion is compatible with the often made observation that familiar faces are particularly difficult to name (e.g. Burke *et al.*, 1991).

An alternative view to the phonological output lexicon being the single locus of AoA is that the representations of all familiar words, faces or objects (including the phonological output lexicon) are organised in a way that produces an effect of AoA. This could include the representation of lexical items in the semantic lexicon (*lemmas*). If the speed of selecting an appropriate lemma in the semantic lexicon, common to input and output, is affected by AoA this locus alone would provide an account for the effect of AoA on auditory and visual lexical decision, picture naming and word naming. However, this locus could not account for an effect of AoA on face familiarity decision.

The challenge for any cognitive model is to account for the effects of word frequency as well as AoA. Age of acquisition may be a feature of the representation of information while word frequency may reflect the strength of connections. One challenge for such an account is to explain why there is no effect of word frequency on *auditory* lexical decision (Turner *et al.* in press).

6.6 Modelling the effects of age of acquisition and cumulative frequency.

The effects AoA have been established for tasks involved in the processing of words and objects. In this thesis the effects of AoA have also been demonstrated in the domain of person recognition and naming. The effects of AoA in these domains present serious problems for current computer modelling of cognition. Connectionist models that use backward error propagation to learn distributed representations, can readily model the effects of cumulative frequency (or familiarity). However, these networks suffer from interference of early learned material by subsequently acquired material. Therefore, it is not clear how such an architecture could model an effect of AoA. Interactive activation models of face recognition and naming do not generally include a learning mechanism, however Burton (1994) has developed an algorithm that enables interactive activation models to learn localist representations of new stimuli. It can be readily appreciated how this algorithm can model the effects of cumulative frequency (or familiarity) by increasing the weight of connections between nodes, but whether it could model the combined effects of AoA and cumulative frequency remains to be seen.

Kohonen (1984: 1990) proposed a model based on 'self-organising maps'. This type of network is capable of learning to distinguish between different patterns of input by unsupervised learning. Similar patterns cluster at units in the same area, whereas dissimilar patterns are topographically distant. When Morrison (1993) attempted to simulate the effects of AoA by introducing a specific order of different patterns, there was a suggestion that early acquired patterns remained distributed over a greater area, with later acquired patterns 'sandwiched' between them. Therefore, early encountered patterns played a prominent role in the organisation of the representation of inputs.

Both interactive activation models and models based on backward-error propagation remain unable to simulate the empirical effects of cumulative frequency and AoA combined. Therefore, it remains a challenge to connectionist modelling to provide an adequate model of both AoA and cumulative frequency.

6.7 The mechanisms involved in the effects of age of acquisition

Early acquired celebrities are rated as acquired later than early acquired object names and words. The proportional analysis from Experiment 1 showed that only eight per cent of the celebrities were rated as acquired under twelve years of age. Furthermore, only half of those were rated as acquired under six years of age. Therefore, most early acquired celebrities were rated as first encountered between approximately 6 to 12 year of age. The difference in the AoA of object names and celebrities' names is an important factor for which any proposed mechanism for the effects of AoA must account. It has been proposed that the effects of AoA are a result of a developmental process during which time the phonology of a specific language is established. Such a process may be the source of the effect of AoA for lexical information, but it cannot be the only mechanism. It is an unlikely candidate for the effects of AoA on processing famous faces and names because they were acquired after the initial vocabulary 'spurt' of language acquisition has occurred (i.e. between 18 months to 5 years of age). In addition, critical periods of language development cannot account for effects of temporal order from the patient studies cited in Chapter 1.

6.8 A proposed mechanism for the order of acquisition

The empirical evidence is consistent in failing to show any advantage for early acquired items on the speed of semantic decisions (e.g. whether objects are man-made or natural, or the occupational categories of celebrities). This suggests that semantic memory may be organised in a fundamentally different manner to perceptual and lexical information: AoA may be a general property of perceptual and lexical representations but not of semantic memory. This conclusion may be premature, the neuropsychological evidence discussed in Chapter 1 (e.g. Verfaellie *et al.* 1995; Shallice & Kartsounis, 1993) which suggests that the *order* of acquisition affects semantic memory must be born in mind. Rosch *et al.*, (1976) also argue that the effects of AoA are apparent in semantic memory and affect category decisions (e.g. that participants show a preference for the early acquired "apple" over the later acquired "fruit").

The order of acquisition provides a more plausible explanation for the effects of AoA on face and name processing. Several authors have suggested that order may influence the effects of AoA, however, as yet, no mechanism(s) have been proposed. It is possible that *all* new patterns of information are processed in a fundamentally different way to later acquired 'related' material. It may be the case that initial encounters of exemplars for *any* new class of information (at any age) could trigger a fundamental organisation of the relevant information to set-up a new processing module. Later acquired related information would be added to the previous material and may be represented in a different manner to earlier acquired information. For example, later acquired information may be represented in a less complete or holistic manner, as proposed by Brown and Watson's (1987) completeness hypothesis.

Such a mechanism as that proposed above may also serve to clarify the specific roles of frequency and AoA. It is assumed that the initial unique patterns of information are used for the set-up or 'formatting' of a dedicated processing module. However, there is a requirement for frequent exposure of appropriate stimuli to maintain the activity or connection strength. What results is an economical method for dealing with early exemplars of new classes of information, because a unit would be created to meet the demands of processing unique patterns of information within the environment and fade if required for a circumscribed period only. When the same ilk of information occurs it would be incorporated into the existing module in an add-on fashion, consistent with the completeness hypothesis.

This approach suggests some future lines of research. First, it suggests that it should be possible to demonstrate an effect of AoA for any modular input system (Fodor, 1983). According to the principle of modularity a variety of cognitive skills are mediated by a number of independent cognitive processes (e.g. face recognition, word recognition). Each module performs a particular type of processing, independent of the activity in other modules, although there is obviously communication between output of these systems. Interestingly, Fodor proposed that faces would be candidates for a modular processing system (cf. Experiment 5). Although Fodor proposed that modular systems are innate, processing of written language is a good example of a skill that is only learnt with considerable instruction and effort. Nevertheless, there is considerable evidence of modular organisation of reading skills. Following this line of thought would suggest that the effects of AoA may be found in any area of highly skilled recognition of a stimulus class. The changes in representation that underlie the effects of AoA may underlie expert - novice differences in a wide range of skills.

6.9 Conclusions

It is clear that the results of the experiments reported in this thesis support the position that the age of acquiring information affects later processing speeds, even when the information (e.g. knowledge of famous people) is acquired later in life than that associated with the development of language.

A strong case can be made against the proposals of a single locus at the phonological output lexicon (such as proposed by Morrison *et al.*, 1992; Barry *et al.*, 1997) because face familiarity cannot be assumed to access the phonological output lexicon automatically.

The results reported in this thesis have been interpreted as suggesting that the generally accepted locus for the effect of AoA may be inadequate to account for the empirical data. However, the results are consistent with a proposed system dedicated to the representation of specific patterns of unique information, created after the period of language development.

The speed of object naming, lexical processing, face and name processing have been shown to be affected by age of acquisition. Spoken word frequencies (e.g. the Celex data base, Baayen *et al.*, 1993) have been shown to effect object and lexical processing, whereas rated familiarity with a famous person (or cumulative frequency) has been shown to affect recognition and naming of famous faces and names. It is possible that word frequency and AoA are interdependent because of the similarity of the effects on certain cognitive processing (e.g. high frequency words and early acquired words are read more quickly than are low frequency or late acquired words). Similar mechanisms and loci have been proposed for the effects of word frequency and for the effects of AoA. For example, a locus at the level of the lexeme has been proposed to account for the effects of word frequency (e.g. Jescheniak & Levelt, 1994). The same locus has been proposed to account for the effects of AoA (e.g. Barry *et al.* submitted). It is possible that these two variables are not entirely mutually exclusive. However, it is clear from the effects of AoA cited in the literature and the results reported in this thesis, that the effects of AoA are not, as suggested by Seidenberg, Peterson, MacDonald and Plaut (1996) "interchangeable" with word frequency.

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Appendix 2.1: An example of the name generation sheet.

Age..............................   Sex   Male Female

Right Handed   Left Handed

FIVE FAMOUS PEOPLE I REMEMBER FROM BEFORE MY TENTH BIRTHDAY WHO ARE NO LONGER IN THE PUBLIC EYE

NAME	FAMOUS FOR ?
1.	
2.	
3.	
4.	
5.	

FIVE FAMOUS PEOPLE I REMEMBER FROM BEFORE MY TENTH BIRTHDAY WHO ARE STILL FAMOUS TODAY

NAME	FAMOUS FOR ?
1.	
2.	
3.	
4.	
5.	

FIVE FAMOUS PEOPLE I REMEMBER FROM THE PAST TEN YEARS

NAME	FAMOUS FOR ?
1.	
2.	
3.	
4.	
5.	

I WOULD BE WILLING TO PARTICIPATE IN EXPERIMENTS

NAME ____________________

CONTACT ADDRESS/PHONE No. ____________________

Appendix 2.2: A sample of the names rating sheet.

RESPONSE SHEET FOR VIV MOORE RATINGS FOR THE FAMILIARITY OF FAMOUS NAMES

NAME:.................................AGE:-.......................SEX:- MALE FEMALE

Below are a list of famous names. These people have been famous during different periods of time. Your tasks are:-
1. Read the names, and decide how familiar you are with that person and give it a score from 1 to 7 with 1 being completely unknown to you and 7 representing someone that you feel is very famous (circle the appropriate number).

2. Then go onto the next stage of assessing when you remember that person being famous by circling the appropriate letter. Choose one of three categories:-

A. EARLY ONLY. People who were famous before your tenth birthday, but are no longer in the public eye.
B. STILL FAMOUS. People who were famous before your tenth birthday, and are still famous today.
C. NEW. People who have only become famous during the past ten years (or if you are 20 years or younger, then people who have become famous since your tenth birthday).

3. Finally decide what you think that person is most famous for, e.g. sport, actor, TV personality, politics etc.

*** **Please go through the sheets in the order they are stapled together and disregard the name-number.**

I WILL PAY £2.00 FOR EACH COMPLETED RESPONSE SHEET.PLEASE RETURN IT TO ME IN ROOM 43 TO COLLECT YOUR MONEY

....

	HOW FAMILIAR 1=unknown 7=well known;	WHEN FAMOUS A=early: B=still fam.: C=new)	FAMOUS FOR ?
1. Cliff Richards	1 2 3 4 5 6 7	A B C	______
2. Charlie Chaplin	1 2 3 4 5 6 7	A B C	______
3. Terry Wogan	1 2 3 4 5 6 7	A B C	______
4. Bruce Forsyth	1 2 3 4 5 6 7	A B C	______
5. Harrison Ford	1 2 3 4 5 6 7	A B C	______
6. Christopher Reeve	1 2 3 4 5 6 7	A B C	______
7. Sean Connery	1 2 3 4 5 6 7	A B C	______
8. Kevin Keegan	1 2 3 4 5 6 7	A B C	______
9. Frank Bruno	1 2 3 4 5 6 7	A B C	______
10. Eric Clapton	1 2 3 4 5 6 7	A B C	______
11. Paul McCartney	1 2 3 4 5 6 7	A B C	______
12. Goldie Horn	1 2 3 4 5 6 7	A B C	______
13. Tina Turner	1 2 3 4 5 6 7	A B C	______
14. Michael Jackson	1 2 3 4 5 6 7	A B C	______
15. David Bowie	1 2 3 4 5 6 7	A B C	______
16. Chris Tarrant	1 2 3 4 5 6 7	A B C	______
17. Michael Foot	1 2 3 4 5 6 7	A B C	______
18. Sabastian Coe	1 2 3 4 5 6 7	A B C	______
19. Rolf Harris	1 2 3 4 5 6 7	A B C	______
20. Tony Hart	1 2 3 4 5 6 7	A B C	______
21. Sarah Greene	1 2 3 4 5 6 7	A B C	______
22. Cilla Black	1 2 3 4 5 6 7	A B C	______
23. John. Noakes	1 2 3 4 5 6 7	A B C	______
24. Mick Jagger	1 2 3 4 5 6 7	A B C	______
25. Jimmy Saville	1 2 3 4 5 6 7	A B C	______
26. Jackie Charlton	1 2 3 4 5 6 7	A B C	______
27. Des O'Conner	1 2 3 4 5 6 7	A B C	______

continued

	HOW FAMILIAR 1=unknown 7=well known;	WHEN FAMOUS A=early: B=still fam.: C=new)	FAMOUS FOR ?
28. Bryan Robson	1 2 3 4 5 6 7	A B C	________
29. George Michael	1 2 3 4 5 6 7	A B C	________
30. Tom Baker	1 2 3 4 5 6 7	A B C	________
31. Maralyn Monroe	1 2 3 4 5 6 7	A B C	________
32. Dianna Spencer	1 2 3 4 5 6 7	A B C	________
33. Bill Beamont	1 2 3 4 5 6 7	A B C	________
34. David Gower	1 2 3 4 5 6 7	A B C	________
35. Kate Bush	1 2 3 4 5 6 7	A B C	________
36. John Cleese	1 2 3 4 5 6 7	A B C	________
37. Penelope Keith	1 2 3 4 5 6 7	A B C	________
38. Joan Collins	1 2 3 4 5 6 7	A B C	________
39. Trevor McDonald	1 2 3 4 5 6 7	A B C	________
40. David Bellamy	1 2 3 4 5 6 7	A B C	________
41. Paul Daniels	1 2 3 4 5 6 7	A B C	________
42. Jerremy Beadle	1 2 3 4 5 6 7	A B C	________
43. Bill Cosby	1 2 3 4 5 6 7	A B C	________
44. Victoria Wood	1 2 3 4 5 6 7	A B C	________
45. Carl Lewis	1 2 3 4 5 6 7	A B C	________
46. Michael Aspel	1 2 3 4 5 6 7	A B C	________
47. Kate Adie	1 2 3 4 5 6 7	A B C	________
48. Margret Thatcher	1 2 3 4 5 6 7	A B C	________
49. Frank Bruno	1 2 3 4 5 6 7	A B C	________
50. Kenny Dalglish	1 2 3 4 5 6 7	A B C	________
51. Elvis Presley	1 2 3 4 5 6 7	A B C	________
52. Noel Edmonds	1 2 3 4 5 6 7	A B C	________
53. Boris Becker	1 2 3 4 5 6 7	A B C	________
54. Nigel Mansell	1 2 3 4 5 6 7	A B C	________
55. Michael Ryan	1 2 3 4 5 6 7	A B C	________
56. David Iyke	1 2 3 4 5 6 7	A B C	________
57. Vic Reeves	1 2 3 4 5 6 7	A B C	________
58. Bob Mortimer	1 2 3 4 5 6 7	A B C	________
59. River Phoenix	1 2 3 4 5 6 7	A B C	________
60. Jack Dee	1 2 3 4 5 6 7	A B C	________
61. John Major	1 2 3 4 5 6 7	A B C	________
62. John Smith	1 2 3 4 5 6 7	A B C	________
63. Paul Gascoine	1 2 3 4 5 6 7	A B C	________
64. Chris Evans	1 2 3 4 5 6 7	A B C	________
65. Patrick Swayze	1 2 3 4 5 6 7	A B C	________
66. Sarah Ferguson	1 2 3 4 5 6 7	A B C	________
67. Freddie Mercury	1 2 3 4 5 6 7	A B C	________
68. Robert Maxwell	1 2 3 4 5 6 7	A B C	________
69. Salamon Rushdie	1 2 3 4 5 6 7	A B C	________
70. George Bush	1 2 3 4 5 6 7	A B C	________
71. Nick Faldo	1 2 3 4 5 6 7	A B C	________
72. Ian Botham	1 2 3 4 5 6 7	A B C	________
73. Mel. Gibson	1 2 3 4 5 6 7	A B C	________
74. Simon Le Bon	1 2 3 4 5 6 7	A B C	________
75. Ben Elton	1 2 3 4 5 6 7	A B C	________
76. Neil Kinnock	1 2 3 4 5 6 7	A B C	________
77. Terry Waite	1 2 3 4 5 6 7	A B C	________
78. Steven Fry	1 2 3 4 5 6 7	A B C	________
79. Jennifer Capriati	1 2 3 4 5 6 7	A B C	________
80. Paul Merton	1 2 3 4 5 6 7	A B C	________
81. Virginia Bottomly	1 2 3 4 5 6 7	A B C	________
82. Bryan Giggs	1 2 3 4 5 6 7	A B C	________
83. Michelle Pfeifer	1 2 3 4 5 6 7	A B C	________
84. Keanu Reeves	1 2 3 4 5 6 7	A B C	________
85. Saddam Hussein	1 2 3 4 5 6 7	A B C	________

continued

	HOWFAMILIAR 1=unknown 7=well known;	WHENFAMOUS A=early: B=still fam.: C=new)	FAMOUS FOR ?
86. Albert Reynolds	1 2 3 4 5 6 7	A B C	
87. Michael Jordan	1 2 3 4 5 6 7	A B C	
88. Bill Clinton	1 2 3 4 5 6 7	A B C	
89. Mikail Gorbactev	1 2 3 4 5 6 7	A B C	
90. Bob Geldoff	1 2 3 4 5 6 7	A B C	
91. Nelson Mandela	1 2 3 4 5 6 7	A B C	
92. Crick Watson	1 2 3 4 5 6 7	A B C	
93. Ronald Reagan	1 2 3 4 5 6 7	A B C	
94. Anthony Burgess	1 2 3 4 5 6 7	A B C	
95. Garry Lineker	1 2 3 4 5 6 7	A B C	
96. Daley Thompson	1 2 3 4 5 6 7	A B C	
97. Les Dawson	1 2 3 4 5 6 7	A B C	
98. Johny Morris	1 2 3 4 5 6 7	A B C	
99. Philip Schofield	1 2 3 4 5 6 7	A B C	
100. Sally Gunnell	1 2 3 4 5 6 7	A B C	
101. Jason Donovan	1 2 3 4 5 6 7	A B C	
102. Kylie Minogue	1 2 3 4 5 6 7	A B C	
103. Dawn French	1 2 3 4 5 6 7	A B C	
104. Sharon Stone	1 2 3 4 5 6 7	A B C	
105. Magic Johnson	1 2 3 4 5 6 7	A B C	
106. Christian Slater	1 2 3 4 5 6 7	A B C	
107. Emmitt Smith	1 2 3 4 5 6 7	A B C	
108. Kevin Keegan	1 2 3 4 5 6 7	A B C	
109. Richard Branson	1 2 3 4 5 6 7	A B C	
110. Cindy Crawford	1 2 3 4 5 6 7	A B C	
111. Naomi Campbell	1 2 3 4 5 6 7	A B C	
112. Brad Pitt	1 2 3 4 5 6 7	A B C	
113. Rowan Atkinson	1 2 3 4 5 6 7	A B C	
114. George Formby	1 2 3 4 5 6 7	A B C	
115. Stu' Francis	1 2 3 4 5 6 7	A B C	
116. John Craven	1 2 3 4 5 6 7	A B C	
117. Adam Ant	1 2 3 4 5 6 7	A B C	
118. Muhamid Ali	1 2 3 4 5 6 7	A B C	
119. Tracy Ullman	1 2 3 4 5 6 7	A B C	
120. Rick Astley	1 2 3 4 5 6 7	A B C	
121. Kieth Chegwin	1 2 3 4 5 6 7	A B C	
131. Brian Cant	1 2 3 4 5 6 7	A B C	
132. Steve Cram	1 2 3 4 5 6 7	A B C	
133. Michel Plantini	1 2 3 4 5 6 7	A B C	
134. Norris McWhirter	1 2 3 4 5 6 7	A B C	
135. John Lennon	1 2 3 4 5 6 7	A B C	
136. Larry Grayson	1 2 3 4 5 6 7	A B C	
138. Kenny Everett	1 2 3 4 5 6 7	A B C	
139. Michael Foot	1 2 3 4 5 6 7	A B C	
140. Steve Ovett	1 2 3 4 5 6 7	A B C	
141. Norris McWhirter	1 2 3 4 5 6 7	A B C	
142. Bonnie Langford	1 2 3 4 5 6 7	A B C	
143. Boy George	1 2 3 4 5 6 7	A B C	
144. Athur Scargill	1 2 3 4 5 6 7	A B C	
145. Tony Curtis	1 2 3 4 5 6 7	A B C	
146. Dianna Durban	1 2 3 4 5 6 7	A B C	
147. Shirley Temple	1 2 3 4 5 6 7	A B C	
148. Jimmy Carter	1 2 3 4 5 6 7	A B C	
149. Pam Ayres	1 2 3 4 5 6 7	A B C	
150. Val Doonigan	1 2 3 4 5 6 7	A B C	
151. Ed Stewart	1 2 3 4 5 6 7	A B C	
152. Tommy Cooper	1 2 3 4 5 6 7	A B C	
153. Andrew Ridgley	1 2 3 4 5 6 7	A B C	

continued

	HOW FAMILIAR	WHEN FAMOUS	FAMOUS FOR ?
	1=unknown 7=well known;	A=early: B=still fam.: C=new)	
154. Cheryl Baker	1 2 3 4 5 6 7	A B C	________
155. Harold Wilson	1 2 3 4 5 6 7	A B C	________
156. Jeoff Capes	1 2 3 4 5 6 7	A B C	________
157. Adolf Hitler	1 2 3 4 5 6 7	A B C	________
158. Jessie Owens	1 2 3 4 5 6 7	A B C	________
159. Peter Duncan	1 2 3 4 5 6 7	A B C	________
160. Johnny Morris	1 2 3 4 5 6 7	A B C	________
161. Eric Morcombe	1 2 3 4 5 6 7	A B C	________
162. Michael Foot	1 2 3 4 5 6 7	A B C	________
163. Nicholas Parsons	1 2 3 4 5 6 7	A B C	________
164. Derek Battie	1 2 3 4 5 6 7	A B C	________
165. Rod Hull	1 2 3 4 5 6 7	A B C	________
167. Danny Baker	1 2 3 4 5 6 7	A B C	________
168. Mike Read	1 2 3 4 5 6 7	A B C	________
169. Simon Groom	1 2 3 4 5 6 7	A B C	________
170. Toyah Wilcox	1 2 3 4 5 6 7	A B C	________
171. Andy Warhol	1 2 3 4 5 6 7	A B C	________
172. Brook Shields	1 2 3 4 5 6 7	A B C	________
173. Ricky Schroeder	1 2 3 4 5 6 7	A B C	________
174. Olivia Newton John	1 2 3 4 5 6 7	A B C	________
175. Peter Skellern	1 2 3 4 5 6 7	A B C	________
176. Jimmy Saville	1 2 3 4 5 6 7	A B C	________
177. Peter Davison	1 2 3 4 5 6 7	A B C	________
178. James Galway	1 2 3 4 5 6 7	A B C	________
179. Michael Crawford	1 2 3 4 5 6 7	A B C	________
180. Shakin Stvens	1 2 3 4 5 6 7	A B C	________
181. Edwina Currey	1 2 3 4 5 6 7	A B C	________
182. Richard Burton	1 2 3 4 5 6 7	A B C	________
183. Eric Idle	1 2 3 4 5 6 7	A B C	________
184. Sinaide O'Conner	1 2 3 4 5 6 7	A B C	________
185. Rick Mayo	1 2 3 4 5 6 7	A B C	________
189. Tommy Steele	1 2 3 4 5 6 7	A B C	________
190. Peter Snow	1 2 3 4 5 6 7	A B C	________
191. Anneka Rice	1 2 3 4 5 6 7	A B C	________
192. Angela Rippon	1 2 3 4 5 6 7	A B C	________
193. Lenny Henry	1 2 3 4 5 6 7	A B C	________
194. Bryan Redhead	1 2 3 4 5 6 7	A B C	________
195. Joanna Lumley	1 2 3 4 5 6 7	A B C	________
196. Tony Hancock	1 2 3 4 5 6 7	A B C	________
197. Elizabeth Taylor	1 2 3 4 5 6 7	A B C	________
198. Danny Davito	1 2 3 4 5 6 7	A B C	________
199. Bruce Reynolds	1 2 3 4 5 6 7	A B C	________
200. Paul Newman	1 2 3 4 5 6 7	A B C	________
201. Danny Baker	1 2 3 4 5 6 7	A B C	________
202. Steve McQueen	1 2 3 4 5 6 7	A B C	________
203. Paddy Ashdown	1 2 3 4 5 6 7	A B C	________
204. Kenneth Clarke	1 2 3 4 5 6 7	A B C	________
205. Debby Harry	1 2 3 4 5 6 7	A B C	________
206. Paul Gascoigne	1 2 3 4 5 6 7	A B C	________
207. Stuart Hall	1 2 3 4 5 6 7	A B C	________
208. Harry Enfield	1 2 3 4 5 6 7	A B C	________
209. Peter Purves	1 2 3 4 5 6 7	A B C	________
210. Valery Singleton	1 2 3 4 5 6 7	A B C	________

Appendix 2.3: Experiment 1, Correct full name scores for all items, showing the mean reaction times and the number of correct full name responses.

	Fam	Dist	AoA	Freq	Pheme	RT	CR
WOODY ALLEN	5.10	4.70	5.57	226	4/4 (8)	3391.00	28
PADDY ASHDOWN	4.86	2.90	5.85	1	4/5 (9)	1547.64	22
MICHAEL ASPEL	5.21	2.37	4.76	0.38	5/5 (10)	3413.29	28
ROWAN ATKINSON	6.43	5.70	5.50	96	4/8 (12)	1819.42	29
RONNY BARKER	5.70	4.73	4.07	131	4/4 (8)	3676.24	29
BILL BEAUMONT	4.57	2.53	5.79	27	3/6 (9)	3139.73	22
BORIS BECKER	3.75	2.73	5.91	2	5/4 (9)	2166.78	18
DAVID BELLAMY	5.50	5.03	3.83	12	5/6 (11)	2264.67	30
CILLA BLACK	6.23	3.83	4.87	57	4/4 (8)	1292.57	30
DAVID BOWIE	4.80	3.50	5.03	4	5/3 (8)	2217.30	24
RICHARD BRANSON	5.60	3.93	5.69	4	5/7(12)	2810.52	29
GEORGE BUSH	6.03	2.77	5.97	9	3/3 (6)	2345.06	30
JENNIFER CAPRIATI	4.12	2.00	6.31	0	6/8 (14)	2869.65	23
JIMMY CARTER	3.61	2.43	5.48	222	4/4 (8)	3148.63	16
PAT CASH	3.45	3.43	6.00	23	3/3 (6)	1601.92	14
CHARLIE CHAPLIN	4.34	5.10	3.78	5	4/6 (10)	1516.25	24
KENNETH CLARKE	6.07	3.73	4.83	325	5/4 (9)	4197.50	28
JOHN CLEESE	5.62	2.20	6.67	0	3/4 (7)	1821.08	24
BILL CLINTON	6.03	4.37	4.77	7	3/7 (10)	1963.82	28
JOAN COLLINS	5.77	3.27	5.27	169	3/6 (9)	1842.89	28
PHIL COLLINS	5.40	4.13	4.67	169	3/6 (9)	2573.74	27
SEAN CONNERY	4.33	4.80	4.15	1	3/6 (9)	2068.52	23
TOMMY COOPER	4.45	2.33	4.58	269	4/4 (8)	3678.39	18
MICHAEL CRAWFORD	5.04	4.27	6.46	54	5/6 (11)	2261.43	21
CINDY CRAWFORD	5.67	3.37	3.93	54	5/6 (11)	1177.31	29
PAULS DANIELS	5.30	5.07	4.47	69	3/7 (10)	3017.11	27
LES DAWSON	5.37	5.73	4.00	152	3/5 (8)	2422.25	28
KEN DODD	5.50	2.77	5.90	58	3/3 (6)	1957.44	29
JASON DONOVAN	4.86	3.80	4.92	12	5/7 (12)	2618.00	23
CLINT EASTWOOD	5.50	2.87	6.03	42	5/6 (11)	1951.93	29
BEN ELTON	5.32	2.27	6.38	3	3/5 (8)	3095.05	21
HARRY ENFIELD	5.50	4.13	6.79	.38	4/7 (11)	2751.14	22
CHRIS EVANS	6.10	2.70	5.70	368	4/5 (9)	1738.64	28
SARAH FERGUSON	6.27	4.97	4.27	53	5/7 (13)	2456.93	30
BRUCE FORSYTH	3.52	4.27	5.33	11	4.5 (9)	2773.72	18
MICHAEL FOOT	4.04	2.63	5.92	1.5	5/3 (8)	2282.65	23
DAWN FRENCH	5.93	4.40	6.00	32	3/5 (8)	2916.00	30
STEPHEN FRY	5.45	2.87	6.31	5	5/3 (8)	1970.14	29
PAUL GASCOIGNE	4.54	2.90	5.92	.38	3/6 (9)	2266.70	23
MIKE GATTING	5.08	3.93	5.12	0	3/5 (8)	3505.67	24
BOB GELDOFF	5.30	3.37	6.07	0	3/6 (9)	3078.46	26
MEL GIBSON	5.04	3.47	5.83	135	3/6 (9)	1712.47	30
MIKHAIL GORBACHEV	4.04	3.67	5.04	0	5/8 (13)	3741.68	22
TONY HANCOCK	5.83	4.47	3.40	54	4/6 (10)	2271.89	29
ROLF HARRIS	6.23	4.53	4.97	165	4/5 (9)	2294.53	30
LENNY HENRY	4.93	3.00	6.10	.38	4/5 (9)	4073.63	25
ANTHONY HOPKINS	4.68	4.90	5.35	55	6/7 (13)	3953.32	22
DENNIS HEALEY	5.83	3.93	5.67	64	5/4 (9)	2347.70	23
MICHAEL HESTALTINE	5.59	3.50	6.54	0	5/8 (13)	3609.09	22
IAN HYSLOP	3.95	2.77	6.05	4	3/6 (9)	3058.68	19
GLENDA JACKSON	6.67	5.33	4.67	545	6/6 (12)	946.20	29
MICHAEL JACKSON	5.37	5.00	4.73	545	5/6 (11)	2540.79	29
MICK JAGGER	5.87	4.23	5.73	5	3/4 (7)	2888.63	30
CLIVE JAMES	3.85	2.4	5.13	111	4/4 (8)	2780.47	17
KEVIN KEEGAN	6.07	3.17	5.47	6	5/5 (10)	2470.20	30
NEIL KINNOCK	4.87	2.00	5.07	0	4/5 (9)	2199.29	27
SUE LAWLEY	4.74	3.27	5.64	5	2/4 (6)	2110.22	23

continued

	Fam	Dist	AoA	Freq	Pheme	RT	CR
IVAN LENDL	4.70	2.20	5.37	0	4/6 (10)	3371.60	25
LES DENNIS	4.90	2.30	5.97	22	3/5 (8)	2739.60	27
GARRY LINEKER	5.83	4.27	5.17	0.76	4/6 (10)	2258.80	29
JOANNA LUMLEY	5.77	2.97	4.10	2.7	5/5 (10)	1992.62	29
PAUL MAC CARTNEY	5.17	2.90	4.53	0	3/7 (10)	1936.13	30
JOHN MACKINROE	6.87	2.77	6.27	0.76	3/7 (10)	1124.70	30
JOHN MAJOR	4.22	3.93	5.96	8	3/4 (7)	2228.48	21
ROBERT MAXWELL	5.73	4.93	5.07	30	5/7 (12)	2083.82	29
FREDDY MERCURY	5.64	2.83	5.55	0	5/7 (12)	2393.89	27
IAN MCCASKILL	5.14	2.77	5.83	0.76	3/8 (11)	1353.18	29
KYLIE MINPGUE	4.24	4.07	4.68	0.76	4/5 (9)	2567.86	21
ROGER MOORE	5.19	3.20	6.41	227	4/2 (6)	2032.23	26
VIC REEVES	4.59	2.40	4.73	36	3/4 (7)	3487.90	21
DES O'CONNER	4.69	4.77	6.07	54	3/5 (8)	1420.16	25
SINEAD O'CONNER	5.86	3.17	5.62	54	3/5 (8)	1904.81	27
MICHAEL PALIN	4.69	2.77	5.00	22	5/5 (10)	2552.75	24
MICHAEL PARKINSON	4.12	2.27	6.26	63	5/8 (13)	3103.00	18
CHRIS PATTON	6.03	5.17	6.17	5	4/5 (9)	1556.69	29
LUCIANO PAVAROTTI	4.93	4.33	6.07	0	6/8 (14)	1862.96	22
MICHELLE PFEIFER	4.37	2.87	4.69	0	5/4 (9)	2002.33	17
RIVER PHOENIX	5.80	4.40	4.70	0.76	6/4 (10)	2212.82	28
EASTER RANTZEN	6.03	3.57	4.90	0	4/6 (10)	1748.17	29
RONALD REAGAN	4.55	3.13	6.30	29	6/5 (11)	2299.35	17
KEANU REEVES	6.07	2.93	3.83	36	4/4 (8)	1566.18	28
CLIFF RICHARD	4.22	3.83	6.20	83	4/6 (10)	2561.57	24
JULIA ROBERTS	3.96	3.07	4.70	412	5/6 (11)	3027.45	20
TED ROGERS	5.67	3.07	6.10	128	3/5 (8)	2564.76	29
JOHNATHON ROSS	6.17	3.83	3.27	74	7/3 (10)	2229.80	30
JIMMY SAVILLE	4.18	3.40	5.14	2	4/5 (9)	2972.28	25
ARTHER SCARGILL	5.90	2.97	5.50	0.76	3/6 (9)	2271.84	30
PHILLIP SCHOFEILD	5.17	2.23	6.31	103	5/8 (13)	3338.00	24
TONY SLATTERY	5.48	2.23	6.61	8	4/7 (11)	1436.41	22
JOHN SMITH	5.37	3.27	5.47	1152	3/4 (7)	4107.00	25
MEL SMITH	6.77	3.60	4.50	1152	3/4 (7)	1239.38	26
DIANNA SPENCER	5.24	3.13	5.39	101	5/6 (11)	2232.71	24
SYLVESTER STALLONE	5.00	3.50	5.96	0	7/6 (14)	2217.38	21
MERYL STREEP	5.57	3.37	5.86	0	5/5 (10)	3195.67	30
PATRICK SWAYZE	3.77	4.53	5.18	0	6/5 (11)	1668.00	18
LIZ TAYLOR	6.83	4.40	4.17	716	3/4 (7)	879.87	30
MARGRET THATCHER	5.28	4.67	5.14	5	6/4 (10)	1473.75	28
TINA TURNER	5.50	3.40	5.34	269	4/4 (8)	2001.58	26
ROBIN WILLIANS	6.23	3.03	4.13	504	5/7 (12)	1283.70	27
TERRY WOGAN	4.39	3.00	5.43	0.38	6/6 (12)	2877.15	28
VICTORIA WOOD	4.50	2.20	5.38	364	8/4 (12)	1476.67	24

Key
Fam = rated familiarity; Dist. = rated distinctiveness of face; AoA = rated age of acquisition
Pheme = the number of phonemes for each name firstname/surname (full name); Freq. Log (x+1) surname frequency; RT = the raw mean scores of reach full name correct response and CR= the number of correct full name responses.

APPENDIX 2.4
FOUR PILOT STUDIES.

Introduction.

The purpose of the following experiments was to investigate the effect of AoA. The first two experiments were over-ambitious in attempting to manipulate two variables orthogonally. However, the *post hoc* ratings did not confirm the validity of the stimulus sets and introduced a bias into the design. The second two experiments attempted to isolate two groups of stimuli that were significantly different on AoA, while matched on the remaining variables. As these four studies are reported in the appendices, the mean data and analyses output tables are included in the relevant results sections.

Experiment 2.4.1 manipulated AoA and surname frequency, Experiment 2.4.2 manipulated AoA and recency of encounter (this refers to a rating of how recently celebrities had been in the participants' personal domain). Manipulating variables into groups proved to be over ambitious and the results inconclusive. Therefore, Experiment 2.4.3 identified two groups of celebrities with matched scores on all attributes other than AoA for an analysis of data from Experiment 1. Experiment 2.4.4. reports a replication of Experiment 1 using the selected items only in a factorial design. The *post hoc* ratings derived from participants in Experiment 2.4.4 did not confirm the validity of the stimulus sets and introduced a bias into the design. The bias was in favour of *late* AoA, but the non significant naming speed advantage was in favour of *early* AoA. Further subsets of celebrities were identified and are reported as Experiment 2 and replicated in Experiment 3 (Chapter 3).

EXPERIMENT 2.4.1: FACTORIAL MANIPULATION OF AGE OF ACQUISITION AND SURNAME FREQUENCY.

2.4.1.i Introduction.

Valentine et *al.* (1991) found an effect of surname frequency analogous to the effect of word frequency when surnames were read aloud. Valentine and Moore (1995) found an advantage for the production of low frequency surnames in a famous face naming tasks. However, there was no effect of surname frequency in Experiment 1. Valentine and Moore's study required participants to produce the surnames they had been practised in naming. In Experiment 1 participants were required to produce the full name, therefore *surname* frequency would be expected to have less effect. Also participants did not name the faces overtly on the prior presentation from Experiment 1. Naming practice reduces the number of errors and naming latencies compared to those reported in Experiment 1. It may be necessary to reduce the variance in naming data by practice before an effect of surname frequency is observed. The factorial manipulations from Valentine and Moore's study employed extreme values of surname frequency but surname frequency was a continuous variable in Experiment 1.

In this study both surname frequency and AoA will be manipulated orthogonally, in a replication of the Valentine and Moore' paradigm. Participants will name the faces twice using only the surnames.

2.4.1.ii Method

Participants There were 30 participants in this experiment (18 female and 6 male) with a mean age of 20.04 years (s.d. = 1.25), they were paid £2 on completion of the experiment.

Materials and Apparatus Materials were derived from Experiment 1. The mean AoA rating score for celebrities and the mean log surname frequency of celebrities' names were listed in rank order. Items that had a corresponding position at the top and bottom were isolated and manipulated into four sets of items with familiarity, distinctiveness and phoneme length matched. Thus, 32 items were manipulated to create four distinct categories with 8 celebrities in each cell. The categories were: Early age of acquisition, low surname frequency: Early age of acquisition, high surname frequency: Late age of acquisition, low surname frequency and late age of acquisition, high surname frequency. The mean scores for each group appear in Table 1.

Table 1: Age of acquisition and surname frequency measures in the experimental group.

	Fam.	Dist.	AoA	Frequ.	Phoneme
Early AoA, Low Frequency	**5.40**	**3.50**	**4.68**	**.21**	**4.88**
s.d.	.83	.90	.65	.45	1.13
Early AoA, High Frequency.	**5.38**	**3.62**	**4.54**	**2.11**	**5.75**
s.d.	1.01	1.14	.54	.36	1.17
Late AoA, Low Frequency.	**5.27**	**3.12**	**6.13**	**.54**	**5.50**
s.d.	.91	.81	.25	.39	1.41
Late AoA, High Frequency.	**5.15**	**3.22**	**6.07**	**2.01**	**5.38**
s.d.	.62	.80	.33	.57	1.06

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition,
Frequ. = Log (x+1) surname frequency, Phoneme = Number of phonemes in the surname.

The results of two tailed unrelated *t*-tests showed highly significant differences between early (mean = 4.51, s.d. = .58) and late AoA (mean = 6.01, s.d. = .29) $t(2,28)=8.23$, $p<.0001$. There were highly significant differences between high (mean = 210, s.d. 291) and low (mean = 2.43, s.d. = 2.43) surname frequency $t(2,28)=2.85$, $p<.01$. The statistical differences between the four groups are shown in Table 2.

Design This was a two way within-participants and between-items design with two levels of AoA (early vs. late) and surname frequency (low vs. high). The dependant variables were latency to produce the correct *surname* and accuracy of response.

Table 2: Statistical differences between the four groups.

	Fam.	Dist.	AoA	Frequ.	Phme.
Early LF Vs Late , LF	n.s.	n.s.	$t = 5.40, p < .01$	n.s.	n.s.
Early, HF vs. Late , HF	n.s.	n.s.	$t = 5.90, p < .01$	n.s.	n.s.
Early LF vs. Early HF	n.s.	n.s.	n.s.	$t = 8.5, p < .01$	n.s.
Late , LF vs. Late HF	n.s.	n.s.	n.s.	$t = .5.2, p < .01$	n.s.

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of Acquisition; Frequ. = Log (x+1) surname frequency (LF = low frequency & HF = high frequency), Phme = the number of phonemes in the surname, n.s. = not statistically significant

Procedure The face naming instructions and method of procedure were similar to those reported in Experiment 1 with three changes. Participants were required to use only the *surname* of each celebrity and the celebrities were presented for naming twice (Valentine & Moore, 1995). That is all of the celebrities were presented for naming and then the whole process was repeated with the faces presented in a different random order. The experiment began with the '*' focal point, participants indicated readiness by tapping the desk. The experimenter initiated the face-presentation. Participants named each face by saying the surname of each celebrity. The third change was that the rating of celebrities' faces was performed after the naming tasks were completed.

There were two parts to the naming task, in the first participants were required to name celebrity faces by using their surnames only. If they could not produce the surname it was provided for them and they were asked to repeat the name aloud. On the second presentation no assistance was given. When the vocal response was detected by the throat microphone the display was terminated, and the naming latency logged by the computer. The experimenter entered a response via the keyboard to indicate whether the naming response was accepted or rejected. Celebrity faces were randomised for each presentation.

When the naming task was finished, participants rated the 32 celebrities' faces for familiarity, distinctiveness and AoA, as described for Experiment 1. The experiment and ratings took approximately 20 to 30 minutes. Finally participants were debriefed.

2.4.1.iii Results

There was a high proportion of errors (54%) for the first presentation therefore only naming latencies from the second presentation were analysed. The mean naming latency of correct responses and number of correct responses to the 32 celebrity faces in the test phase were calculated and analysed taking participants as the random factor (F_1) and taking items as the random factor (F_2).

Naming Latencies *Analysis by Participants* The mean naming latency was 1344 msecs (s.d. = 251 msecs.). A two way analysis of variance evinced a significant main effect of surname frequency F_1 (1,29) = 9.03, $p<.01$, no effect of AoA F_1 (1,29) = .131, $p = .7$, between early (mean = 1337 msecs., s.d = 354 msecs.) and late acquired celebrities (mean = 1321 msecs., s.d. = 353 msecs) by low (mean = 1274 msecs, s.d. = 332 msecs.) and high surname frequency (mean = 1384 msecs, s.d. = 365 msecs.). The analysis of variance output appears in Table 3. The mean scores of participants' data appear in Table 4. There was no interaction F_1 (1,29) = 1.37, $p = .25$.

Table 3: Analysis of variance on participants' reaction time data.

Source of Variation	d.f.	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	29	9977262.972	344043.551			
AoA	1	8017.713	8017.713	.131	.7199	
Error	29	1773700.675	61162.092			1.00
Frequency	1	363997.284	363997.284	9.029	.0054	
Error	29	1169055.262	40312.250			1.00
AoA x Frequency	1	65597.734	65597.734	1.371	.2512	
Error	29	1387826.096	47856.072			1.00

Participants were significantly faster to produce low frequency surnames to celebrities's faces than they were to produce high frequency surnames.

Table 4: Participants' reaction time and accuracy data.

	Early AoA, Low Frequency		Early AoA, High Frequency		Late AoA, Low Frequency		Late AoA, High Frequency	
	R.T.	C.R.	R.T.	C.R.	R.T.	C.R.	R.T.	C.R.
1	2024	7	1767	6	1462	7	1421	7
2	1085	7	1114	6	1310	7	1937	7
3	1287	7	1608	5	1089	7	1465	8
4	1503	6	1702	3	1412	6	1722	3
5	699	5	979	8	663	8	797	7
6	974	2	1289	3	1560	6	1940	7
7	1857	5	1694	6	1609	4	2136	5
8	1421	5	1265	4	1553	5	1646	4
9	870	6	843	4	920	8	874	8
10	841	6	1356	8	979	7	1107	7
11	900	5	1152	2	1378	6	1195	5
12	819	7	841	7	878	8	850	8
13	1330	6	1752	5	1281	4	1329	7
14	1452	7	1827	6	1370	7	1052	6
15	824	7	819	8	912	8	803	7
16	905	8	1448	7	833	8	1037	8
17	1479	4	1701	8	1320	6	1754	6
18	1727	6	1304	5	1351	7	1313	8
19	1993	7	1111	5	1336	6	1819	7
20	857	3	967	6	957	7	1032	7
21	1622	5	1590	4	1112	5	1765	3
22	1563	5	1783	3	1480	6	2006	6
23	1597	5	1586	3	1460	5	1615	5
24	945	6	1381	7	951	8	985	7
25	1156	7	1104	6	1055	7	1008	8
26	1366	5	1394	5	1522	8	2056	6
27	1189	8	1156	6	1375	8	1086	8
28	1765	5	1492	6	1568	6	1330	6
29	1905	6	1734	3	1235	7	1779	8
30	1212	5	1312	4	1346	7	1126	8
x	**1306**	**5.77**	**1369**	**5.30**	**1243**	**6.63**	**1399**	**6.57**
sd	394	1.36	311	1.73	260	1.19	417	1.46

Key RT = Reaction times (in milliseconds), CR = The number of correct responses,

Analysis by Items There were no main effects of AoA $F_2(1,28) = .95$, $p = .3$, or surname frequency $F_2(1,28) = 1.07$, $p = .3$ in a two way analysis of variance. Thus, the differences between early (mean = 1338 msecs., s.d. = 309 msecs.) and late AoA (mean = 1300 msecs., s.d. = 176 msecs.); by low (mean = 1298 msecs., s.d. = 271 msecs.) and high surname frequency (mean = 1391 msecs, s.d. = 229 msecs.) were not significant. (Analysis of variance output appears in Table 5 below and the individual mean scores appear in Table 7.). There was no significant interaction $F_2(1,28) = .09$, $p = .8$.

Table 5: Analysis of variance on reaction time for item data.

Source of Variation	df	Sum of Squares	Mean Square	F	p
AoA	1	61898.332	61898.332	.951	.3378
Frequency	1	69658.714	69658.714	1.070	.3098
AoA x Frequency	1	6136.381	6136.381	.094	.7611
Error	28	1822680.265	65095.724		

Accuracy of Response The mean number of correct responses was 22.75 (s.d. = 4.87).

Analysis by Participants There was a main effect of AoA in a two way analysis of variance (see Table 6) between early (mean = 5.33, s.d. = 1.5) and late acquired celebrities (mean = 6.60, s.d. = 1.23) $F_1(1,29) = 23.64$, p<.0001. There was no main effect between low (mean = 6.20, s.d. = 1.34) and high surname frequency (mean = 5.93, s.d. = 1.71), F_1 (1,29) = 1.83, p =.1. There was no interaction F_1 (1,29) = 1, p =.3.

Table 6: Analysis of variance on participants' accuracy data.

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	29	131.467	4.533			
AoA	1	34.133	34.133	23.643	.0001	
Error	29	41.867	1.444			1.00
Frequency	1	2.133	2.133	1.827	.1870	
Error	29	33.867	1.168			1.00
AoA x Frequency	1	1.200	1.200	1.000	.3256	
Error	29	34.800	1.200			1.00

Table 6 shows that participants were significantly more accurate at producing the surnames of celebrities rated as acquired *late* in life, than they were at producing the surnames of celebrities rated as early acquired.

Analysis by Items Table 7 shows that there was a significant main effect of AoA in a two way analysis of variance between the number of accurate responses for early (mean = 20.75, s.d. = 5.00) and late acquired celebrities (mean = 24.75, s.d. = 3.79) $F_2(3,28) = 6.02$; p<.02. The effect between low (mean = 23.26, s.d. = 4.21) and high surname frequency (mean = 22.26, s.d. = 4.39) approached significance $F_2(3,28) = .38$; p =.6. The interaction between AoA and surname frequency was not significant $F_2(3,28) = .21$; p =.7. More accurate responses occurred for celebrities rated as acquired *late* than occurred for celebrities rated as acquired early.

Table 7: Analysis of variance on accuracy scores in item data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
AoA	1	128.000	128.000	6.018	.0206
Frequency	1	8.000	8.000	.376	.5446
AoA x Frequency	1	4.500	4.500	.212	.6491
Error	28	595.500	21.268		

Post hoc rating scores. Participants had rated each celebrity on three attributes (familiarity, distinctiveness and AoA). The scores for each celebrity are shown in Table 8. The mean scores for each experimental group are summarised with the mean experimental data in Table 9.

The stimulus sets were created by matching the variables other than those being manipulated. This matching was based on *a priori* ratings, but it was found that these ratings were not validated by the ratings given by those participating in the current experiment. The *post hoc* ratings were analysed by unrelated *t* tests and as shown in Table 9, the ratings of familiarity and distinctiveness for the late AoA experimental groups were higher than for the early AoA groups. The results of the *t* tests in Table 10 reveal the late AoA groups had significantly higher ratings of both familiarity and distinctiveness. The higher ratings of familiarity and distinctiveness therefore introduce a bias in favour of late AoA.

Table 8: ***Post hoc*** **rating scores for familiarity, distinctiveness and age of acquisition, also showing reaction times and accuracy data.**

Early age of acquisition low surname frequency celebrities

	Fam.	Dist.	AoA	C.R.	RT
Saville J	5.3	3.6	4.5	25	1143
Rantzen E.	5.4	4.4	5.6	23	1589
Thatcher M.	6.9	4.0	4.9	30	801
Connery S.	5.4	2.9	5.0	16	1750
Scargill A.	4.7	3.5	4.0	20	1353
Lawley S	3.9	2.6	5.6	20	1757
Bowie D.	4.6	3.6	4.8	22	1379
Aspel M	4.2	2.6	5.6	19	1412
mean scores	**5.05**	**3.67**	**5.00**	**21.88**	**1398**
s.d.	.93	.90	.58	4.26	319

Early age of acquisition high surname frequency celebrities

	Fam.	Dist.	AoA	C.R.	RT
Harris R.	5.0	4.3	4.9	20	1608
Collins P.	5.7	2.9	5.7	26	1351
O'Conner D.	4.2	2.8	4.9	16	1483
Spencer D.	6.8	5.1	5.3	26	1153
Jackson M.	6.7	5.5	5.6	29	879
Crawford M.	4.1	2.8	4.7	14	2099
Cooper T	3.7	4.5	3.8	14	1523
Parkinson M.	3.4	2.8	5.2	16	1705
mean scores	**4.96**	**3.39**	**5.01**	**20.13**	**1475**
s.d.	1.30	.60	.60	6.05	366

Late age of acquisition low surname frequency celebrities

	Fam.	Dist.	AoA	C.R.	RT
Pfeifer M.	5.4	4.8	6.9	29	1328
Swayze P.	5.2	4.8	6.7	26	1327
Minogue K.	6.0	4.5	6.6	27	1239
Capriati J.	4.0	4.0	6.8	27	1091
Hyslop I.	4.5	3.7	6.9	19	1466
Patton C.	4.0	4.5	6.7	18	1518
Major J.	6.8	5.0	6.8	29	880
Branson R.	5.5	5.4	6.3	27	1652
mean scores	**5.18**	**3.24**	**6.71**	**25.25**	**1313**
s.d.	.98	1.47	.20	4.03	246

Late age of acquisition high surname frequency celebrities

	Fam.	Dist.	AoA	C.R.	RT
O'Conner S.	4.8	4.0	6.9	28	1301
Ferguson S.	6.1	5.8	6.7	26	1435
Ross. J.	5.4	4.7	6.9	27	1331
Beaumont B.	4.1	5.2	5.9	22	1319
Roberts J	6.0	4.8	6.9	26	1411
Smith J.	5.1	3.2	6.6	26	1408
Gibson M.	5.6	4.6	6.7	19	1803
Reeves. V.	4.8	4.9	6.9	27	1433
mean scores	**5.24**	**3.48**	**6.69**	**25.13**	**1430**
s.d.	0.67	1.42	0.34	3.04	160

Key: Fam = Familairity, Dist. = Distinctiveness, AoA = Age of Acquisition, C.R. = the number of correct responses; R.T. = Reaction time in milliseconds.

The ratings attributed to celebrities by participants in this experiment may have biased the results in favour of late AoA. The measures of AoA were confirmed, however, the differences occurring for familiarity (early mean = 5.05, late mean = 5.17) and distinctiveness (early mean = 4.00, s.d. = .85; late mean = 4.25, s.d. = 1.03) are in the direction of the effect of AoA (i.e. the difference would give an advantage to the late acquired group). This suggests that the advantage in accuracy of response to celebrities rated as late acquired occurred because these celebrities were rated as more familiar and their faces are more distinctive than the early acquired celebrities.

Table 9: Mean *post hoc* rating for the four groups

	Fam.	Dist.	AoA	CR	R.T
Early AoA, Low Frequency.	**5.05**	**3.40**	**5.00**	5.77	**1306**
s.d.	.93	.65	.58	1.24	319
Early AoA x High Frequency.	**4.96**	**3.85**	**5.01**	**5.30**	**1369**
s.d.	1.32	1.13	.60	.92	316
Late AoA x Low Frequency.	**5.18**	**4.59**	**6.71**	**6.63**	**1243**
s.d.	.98	.55	.20	.75	219
Late AoA x High Frequency.	**5.24**	**4.66**	**6.69**	**6.57**	**1340**
s.d.	.67	.78	.34	.89	102

Key: Fam. = Familiarity; Dist = Distinctiveness; AoA = Age of Acquisition; CR = The mean number of correct responses; R.T. = Reaction Time in milliseconds.

Table 10: Statistical differences between the four groups.

	Fam.	Dist.	AoA
Early LF Vs Late, LF	***t*=12, *p*<.0001**	***t*=2.03, *p*<.04**	***t* = 19, *p*<.0001**
Early, HF vs. Late, HF	n.s.	n.s.	***t* = 6.59, *p*<.001**
Early LF vs. Early HF	n.s.	n.s.	n.s.
Late, LF vs. Late HF	n.s.	n.s.	n.s.

Key Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of Acquisition; LF = low surname frequency & HF = high surname frequency, n.s. = not statistically significant.

2.4.1.iv Discussion

When AoA and surname frequency were manipulated orthogonally participants were faster to produce surnames to celebrities' faces when the celebrities had low frequency surnames rather than those with high frequency surnames. This result is consistent with the findings reported by Valentine and Moore (1995).

There was a main effect of AoA for accuracy showing that participants could produce the surname of celebrities rated as acquired *late* in life more accurately that those rated as early acquired. However, because the *post hoc* ratings did not confirm the validity of the stimulus sets, a bias was introduced in the in favour of *late* AoA, because the celebrities in those groups had been rated as more familiar to the participants in the current experiment and the faces of celebrities in the late AoA groups were rated of being more distinctive than celebrities in the early AoA groups.

APPENDIX 2.4.2: FACTORIAL MANIPULATION OF AGE OF ACQUISITION AND RECENCY OF ENCOUNTER.

2.4.2.i Introduction

In Experiment 1 familiarity and AoA significantly accounted for a proportion of variance in the data. However, there remained a large proportion of variance unaccounted for by either AoA or familiarity such variance may be attributable to currently unknown variables, for example, whether a picture was an atypical view of the celebrity (e.g. Roger Moore with a beard), the quality of the images, etc. One possible explanation could be how recently participants had been exposed to pictures of/or information about individual celebrities. Experiment 2.4.2 investigated this possibility by manipulating recency of encounter and AoA as variables. In this experiment recency of encounter refers to a rating of how recently each participant had heard, seen and / or read about a particular celebrity. Recency ratings were first collected for the 101 celebrities from Experiment 1 by sixteen participants.

EXPERIMENT 2.4.2

2.4.2.ii Method

Recency Ratings *Participants* Sixteen first year undergraduate students (8 male, 8 female) from the University of Durham participated in this rating task (mean = 21.44 year, s.d. = 2.35), they were paid £3 for completing all tasks.

Materials and Apparatus Materials and apparatus were described in Experiment 1.

The Recency Rating Scale The seven point scale for the recency ratings began with the score of 1 for an unknown celebrity. Two for a celebrity encountered (heard/ heard of /saw /or read about) some 10 or more years ago. Three for a celebrity last encountered about 5 years ago; four for a celebrity last encountered 2 years ago; five for a celebrity last encountered about 1 year ago; six for a celebrity last encountered during the last six months; and seven for a celebrity last encountered over the past 48 hours. The key of scores appeared on the screen when participants were ready to enter their rating.

Participants were presented with individual faces of celebrities and pressed the space bar when they were ready to enter a rating. The instructions asked participants to decide when they had last encountered each celebrity before the task in hand. Participants were directed to include seeing the celebrity on a poster, or a cartoon, etc.

Table 1: Age of acquisition and recency of encounter measures for the experimental groups.

	Fam.	Dist.	AoA	Frequ.	Rec.	Pheme.
Early AoA, recent	**5.49**	**3.83**	**4.27**	**1.19**	**5.32**	**5.00**
s.d.	.81	.67	.65	.95	.47	1.51
Early AoA, not recent	**4.88**	**4.09**	**4.34**	**1.27**	**4.39**	**5.25**
s.d.	.73	1.24	.40	.88	.44	1.28
Late AoA, recent	**5.06**	**3.71**	**6.00**	**1.15**	**5.35**	**5.38**
s.d.	1.07	1.07	.30	.96	.54	1.41
Late AoA, not recent	**4.93**	**3.10**	**5.45**	**1.28**	**4.93**	**6.00**
s.d.	.88	.49	.50	.83	.68	1.07

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x+1) surname frequency, Rec. = Recency of encounter; Pheme. = Number of phonemes.

The recency of encounter (henceforth 'recency') responses were converted to a six point scale by removing the 'unknown' category. A mean score for each celebrity was derived and their names were listed in rank order. The mean AoA rating score of celebrities were also listed in rank order. Items that had a corresponding position at the top and bottom of both lists were isolated and manipulated into four sets of items.

Familiarity, distinctiveness, surname frequency and phoneme length were matched across the four groups. There were four categories with 8 celebrities in each cell. The categories of items were: Recently encountered, early acquired celebrities: Not recently encountered, early acquired celebrities: Recently encountered, late acquired celebrities and not recently encountered, late acquired celebrities. However, even after the most meticulous care it was impossible to create distinct categories, as revealed in Tables 1 above and Table 2 below. A *t* test showed that the groups did not have significant differences in rated recently and not recently encountered late acquired celebrities. Otherwise, the manipulation and matching of factors was satisfactory.

It is possible that the lack of significant differences in recency for late acquired celebrities may not confound the variables. Obviously late acquired celebrities would have been in the public more eye recently than some early acquired celebrities. A close inspection of the mean scores reveal the direction of disparity alleviates the problem to some extent, because it goes against the predicted working hypothesis, if it is assumed that a recent encounter will facilitate naming. The lack of matching on recency would not lead to a type I error in the test for the predicted effect of AoA for celebrities who have not been encountered recently, but could lead to a type II error.

Table 2: Statistical differences between the experimental groups.

Categories	Fam	Dist	AoA	Frequ	Rec.	Pheme.
Recently encountered, Early AoA x Late AoA.	n.s.	n.s.	**$t = 5.79, p < .01$**	n.s.	n.s.	n.s.
Not recently encountered, Early x Late AoA	n.s.	n.s.	**$t = 5.44, p < .01$**	n.s.	n.s.	n.s.
Early AoA, Recent x Not recently encountered	n.s.	n.s.	n.s.	n.s.	**$t = 3.79$ $p < .01$**	n.s.
Late AoA, Recent x Not recently encountered	n.s.	n.s.	n.s.	n.s.	**n.s.**	n.s.

Key Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x+1) surname frequency; Pheme. = The number of phonemes in the full name.

Faster naming latencies for the most recently encountered celebrities would be detected by the significant difference between recent (mean = 5.43, s.d. = .47) and not recently encountered scores (mean = 4.66, s.d. = .44) $t(2,28) = 2.97$, $p < .01$, despite the imperfect matching, it was decided to run the experiment as an exploratory study of the effect of recency. The mean rating for individual celebrities appear in Table 3

Naming Task *Participants* The 30 participants in this Experiment (mean age 20.04 year, s.d. = 1.2) were students of the North East Universities, they were paid £3 on completion of the experiment.

Apparatus and Material A throat microphone connected to a voice key recorded the time between presentation of each face and initial articulation by the participant. Names were accepted via a code entered into the keyboard by the experimenter. Naming latencies (with millisecond accuracy) were recorded by the computer.

Design This was a within-participants, between-items factorial design with two levels of two factors, AoA (early vs. late) and recency of encounter (recent vs. not recent). As for Experiment 2.4.1, items were presented for naming twice and participants were provided with the name if they could not produce it and asked to repeat the name aloud. There were 8 stimuli in each group. The dependent variables were the naming latency and accuracy of response.

Table 3: A*priori* scores for experimental groups.

Early AoA recently encountered celebrities

	Fam	Dist	AoA	Frequ	Rec	Phm
S. Connery	5.50	4.13	4.67	0.30	5.63	6
P. Daniels	5.67	3.37	3.97	1.85	5.56	7
R. Harris	5.83	4.47	3.47	2.22	5.50	5
D. O'Conner	4.59	2.40	4.70	1.74	5.23	5
J. Saville	6.17	3.83	3.30	0.30	5.63	5
R. Moore	4.24	4.07	4.67	2.36	5.13	2
M. Thatcher	6.83	4.40	4.20	0.78	5.63	4
B. Geldoff	5.08	3.93	5.15	0	4.25	6
mean	**5.49**	**3.83**	**4.27**	**1.19**	**5.32**	**5.00**
s.d.	0.81	0.67	0.65	0.95	0.47	1.51

Early AoA not recently encountered celebrities

	Fam	Dist	AoA	Frequ	Rec	Phm
C. Chaplin	4.35	5.10	3.89	0.78	4.33	6
T. Cooper	4.33	4.80	4.19	2.43	4.27	4
M. Crawford	4.35	2.33	4.54	1.74	4.36	6
K. Dodd	5.37	5.73	4.03	1.77	4.50	3
J. McEnroe	5.17	2.90	4.53	0	4.44	7
T. Rogers	3.96	3.07	4.70	2.11	3.47	5
D. Bellamy	5.50	5.03	3.87	1.11	4.94	6
R. Reagan	6.03	3.73	4.93	0.25	4.81	5
mean	**4.88**	**4.09**	**4.34**	**1.27**	**4.39**	**5.25**
s.d.	0.73	1.24	0.40	0.88	0.44	1.28

Late AoA recently encountered celebrities.

	Fam	Dist	AoA	Frequ	Rec	Phm
J. Roberts	4.22	3.83	6.20	2.62	5.13	6
B. Beaumont	4.57	2.53	5.75	1.42	5.44	6
R. Atkinson	6.43	5.70	5.50	1.99	5.94	8
M. Pfeifer	4.93	4.33	6.04	0	5.20	4
J. Major	6.87	2.77	6.20	0.95	6.00	4
C. Crawford	5.04	4.27	6.46	1.74	5.73	6
M. Streep	4.64	3.50	5.96	0	4.43	5
B. Becker	3.75	2.73	5.91	0.48	4.92	4
mean	**5.06**	**3.71**	**6.00**	**1.15**	**5.35**	**5.38**
s.d.	1.07	1.07	0.30	0.96	0.54	1.41

Late AoA not recently encountered celebrities.

	Fam	Dist	AoA	Frequ	Rec	Phm
T. Hancock	4.04	3.33	5.12	1.74	4.43	6
J. Carter	3.61	2.43	4.46	2.35	4.00	4
J. Donovan	5.50	2.76	5.87	1.11	4.88	7
A. Scargill	4.18	3.40	5.14	0.25	4.31	6
S. Ferguson	6.10	2.77	5.70	1.73	5.56	7
K. Minogue	5.14	2.77	5.87	0.25	4.81	5
M. Gibson	5.30	3.37	5.73	2.13	5.56	6
R. Branson	5.6	3.93	5.72	0.70	5.88	7
mean	**4.93**	**3.10**	**5.45**	**1.28**	**4.93**	**6.00**
s.d.	0.88	0.49	0.50	0.83	0.68	1.07

Key. Fam. = Familiarity, Dis. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x+1) surname frequency, Rec. = Recency of encounter; Phm = The number of phonemes in the full name.

Procedure The procedure was the same as described for Experiment 2.4.1 with the exception of the required response. For this Experiment participants were required to say the *full* name. Participants were presented with the 32 faces and asked to name them as quickly and accurately as possible. If they could not produce the name it was provided for them. They were asked to repeat any such name aloud. The same faces were then re-presented in a different random order for unassisted naming.

Directly following the experiment participants completed the rating tasks for familiarity, distinctiveness, AoA and recency of encounter. Finally participants were debriefed. The experiment and rating tasks took approximately 30 minutes.

2.4.2.iii Results

Naming latencies Analysis by *Participants* Mean naming latency and accuracy of response to the 32 celebrities from the second presentation were calculated for the 30 participants. The mean naming latency was 1245 msec. (s.d. = 383 msec.) the mean number of accurate responses was 6.61 (s.d. = 1.37), the mean group scores appear in Table 4 below. Participants' naming latency and accuracy data appear in Table 5.

Table 4: Participants' mean naming latencies and accuracy of response.

	RECENT		NOT RECENT	
	RT	**CR**	**RT**	**CR**
Early age of acquisition	**1202**	**6.67**	**1253**	**6.13**
s.d.	315	1.49	430	1.38
Late age of acquisition	**1298**	**6.90**	**1227**	**6.73**
s.d.	405	1.89	384	1.36

Key RT = mean reaction time in msecs., CR = The mean number of accurate responses.

Table 6 shows that there were no main effects in a two way analysis of variance between early (mean = 1228 msec., s.d. = 345 msec.) and late acquired celebrities (mean = 1262 msec., s.d. = 392 msec.) $F_1(1,29) = .64, p = .4$; or between recent (mean = 1250 msec., s.d. = 362 msec.) and not recently encountered celebrities (mean = 1240 msec., s.d. = 405 msec.), $F_1(1,29) = .06, p = .8$. Table 6 shows the outcome of a 2 way analysis of variance on the data from Table 5. The interaction between AoA and recency was on the borderline of significance $F_1(1,29) = 4.11, p = .052$, suggesting that celebrities rated as acquired early in life were named faster if they had been recently encountered, but celebrities rated as acquired late in life were names faster when they had not recently been encountered.

Table 5: Participants' reaction times and accuracy data.

	Early AoA x Recent		Early AoA x Not recent		Late AoA x Recent		Late AoA x Not recent	
	R.T.	C.R.	R.T.	C.R.	R.T.	C.R.	R.T.	C.R.
1	1687	6	1873	7	1846	8	1430	6
2	862	8	814	7	880	7	904	8
3	1690	4	1482	8	2046	6	1174	5
4	1124	8	737	5	750	6	766	4
5	939	8	922	8	808	8	918	8
6	1267	8	1271	7	1623	8	1154	8
7	836	8	993	7	893	7	1034	8
8	1367	8	1247	5	1057	7	1028	8
9	1213	5	1024	5	1572	7	1673	5
10	1753	6	2462	3	1749	6	1863	8
11	1276	8	1550	8	1454	8	1325	7
12	1421	4	922	7	1308	8	942	6
13	1210	4	1577	4	1490	5	1755	4
14	797	8	1128	6	881	7	1012	6
15	875	8	1133	8	1154	8	1126	8
16	1285	6	1108	5	959	7	987	6
17	1225	4	1882	4	1760	3	2395	5
18	1228	8	1202	8	1320	6	1140	7
19	1126	6	1163	6	1082	8	979	7
20	1869	5	1336	6	1540	6	1254	5
21	866	8	1177	6	1492	8	1421	8
22	1313	7	2118	5	1296	7	1208	7
23	1024	6	844	4	1283	7	1150	8
24	1564	6	1656	6	2050	6	1879	6
25	1038	8	809	8	857	7	1142	8
26	1062	8	1029	7	1261	7	1094	5
27	936	8	1105	6	1093	8	942	8
28	1612	5	1563	6	1932	5	1616	7
29	995	7	818	6	860	8	796	8
30	613	7	640	6	633	8	672	8
x	**1202**	**6.67**	**1253**	**6.13**	**1298**	**6.90**	**1226**	**6.73**
sd	315	1.49	430	1.38	405	1.19	384	1.36

Key RT = mean reaction time in milliseconds., CR = The mean number accurate of responses.

Table 6: Two way (AoA x Recency) within-participants analysis of variance on naming latencies.

Source of Variation	*df*	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	29	13123199.000	452524.104			
AoA	1	35175.779	35175.779	.644	.4286	
Error	29	1582885.474	54582.258			1.00
Recency	1	3397.033	3397.033	.055	.8157	
Error	29	1780601.870	61400.064			1.00
AoA x Recency	1	111686.737	111686.737	4.105	.0521	
Error	29	789093.201	27210.110			1.00

Analysis by Items Mean reaction times of correct responses for the 30 participants were calculated across the 32 items. The descriptive data are shown in Table 7. The means scores for individual celebrities appear in Table 8. The were no significant main effects between early (mean = 1234 msec., s.d. = 277 msec.) and late acquired celebrities (mean = 1248 msec., s.d. = 207 msec.), $F_2(1,28) = .02, p = .9$; or between recent (mean = 1235 msec., s.d. = 236 msec.) and not recently encounter celebrities (mean = 1248 msec., s.d. = 251 msec) $F_2(1,28) = .02, p = .9$, in a two way analysis of variance (see Table 9).

Table 7: Descriptive data in the four experimental groups.

	RECENT		NOT RECENT	
	RT	**CR**	**RT**	**CR**
Early age of acquisition	**1196**	**25**	**1272**	**23**
s.d.	265	4.1	215	1.7
Late age of acquisition	**1273**	**26**	**1223**	**25**
s.d.	215	1.7	208	3.5

Key RT = mean reaction time in milliseconds., CR = The mean number accurate of responses.

Accuracy Analysis by *Participants* A two way analysis of variance (see Table 10) showed a significant main effect for AoA between early (mean = 6.40, s.d. = 1.45) and late AoA (mean = 6.82, s.d. = 1.27) $F_1(1,29) = 4.87$ $p<.04$. The was also a significant main effect of recency between recent (mean = 6.79, s.d. = 1.34) and not recently encountered celebrities (mean = 6.43, s.d. = 1.40) $F_1(1,29) = 4.94$, $p<.04$. There was no interaction $F_1(1,29) = .79$ $p = .4$. Participants were significantly more accurate to name celebrities who were acquired late in life and have been recently encountered.

Table 8: Mean *post hoc* rating scores for the four experimental groups

Early AoA recently encountered	**Fam.**	**Dist.**	**AoA**	**Rec.**	**C.R.**	**RT**
S. Connery	6.10	3.60	5.00	5.73	25	1297.92
P. Daniels	6.07	4.40	5.40	5.80	28	1136.11
R. Harris	6.03	5.55	5.00	5.67	25	1276.52
D. O'Conner	4.36	2.90	5.18	5.43	18	1650.61
J. Saville	5.93	3.50	4.83	5.40	29	1032.41
R. Moore	5.55	4.60	5.03	5.28	24	1138.33
M. Thatcher	6.80	5.35	5.2	6.23	30	726.80
B. Geldoff	4.90	4.60	5.93	5.27	21	1312.48
x	**5.72**	**4.35**	**5.20**	**5.60**	**25**	**1196.40**
s.d.	0.77	0.93	0.34	0.33	4.07	264.83
Late AoA not recently encountered	**Fam.**	**Dist.**	**AoA.**	**Rec.**	**C.R.**	**RT**
C. Chaplin	5.80	4.30	4.30	4.70	28	1160.79
T. Cooper	4.18	3.94	3.71	4.25	18	1788.44
M. Crawford	4.80	2.80	4.90	5.00	20	1594.95
K. Dodd	4.66	5.10	4.41	4.59	26	1078.08
J. McEnroe	5.10	3.50	5.00	4.77	24	1277.42
T. Rogers	2.94	5.40	3.22	3.67	10	1357.30
D. Bellamy	5.33	5.25	4.87	4.80	28	1030.46
R. Reagan	6.20	5.64	5.17	5.53	30	888.60
x	**4.88**	**4.49**	**4.45**	**4.66**	**23**	**1272.01**
s.d.	1.01	1.02	0.69	0.54	6.68	300.86
Late AoA recently encountered	**Fam.**	**Dist.**	**AoA.**	**Rec.**	**C.R.**	**RT**
J. Roberts	5.70	4.80	6.93	5.77	25	1418.48
B. Beaumont	4.85	4.81	5.96	5.41	25	1192.36
R. Atkinson	6.43	5.85	6.53	6.23	29	1356.03
M. Pfeifer	5.55	4.00	6.79	5.69	26	1518.58
J. Major	6.73	2.70	6.93	6.77	28	809.11
C. Crawford	5.28	4.50	6.93	5.81	24	1379.75
M. Streep	4.83	5.03	6.23	5.20	25	1221.76
B. Becker	5.03	5.40	6.87	5.43	25	1286.12
x	**5.55**	**4.64**	**6.65**	**5.79**	**25.88**	**1272.77**
s.d.	0.71	0.96	0.37	0.51	1.73	215.23
Late AoA not recently encountered	**Fam.**	**Dist.**	**AoA.**	**Rec.**	**C.R.**	**RT**
T. Hancock	4.55	5.80	4.5	4.46	20	1530.70
J. Carter	3.84	3.47	3.56	4.16	21	1416.14
J. Donovan	6.10	4.70	6.80	5.77	28	910.79
A. Scargill	4.6	4.75	4.60	4.80	24	1161.17
S. Ferguson	5.86	5.83	6.86	5.59	29	1121.00
K. Minogue	6.13	4.20	6.90	6.03	28	1121.25
M. Gibson	5.40	3.43	6.80	5.67	24	1414.50
R. Branson	5.55	3.74	6.45	5.72	28	1108.61
x	**5.25**	**4.49**	**5.81**	**5.28**	**25.25**	**1223.02**
s.d.	0.84	0.96	1.36	0.70	3.50	208.33

Key: Fam. = Familiarity, Dis. = Distinctiveness, AoA = Age of acquisition, Rec. = Recency of encounter; RT = reaction time in milliseconds, CR = The number of accurate responses.

Table 9: Two way (AoA x Recency) between-items analysis of variance for naming latencies

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
AoA	1	1500.561	1500.561	.024	.8781
Recency	1	1336.833	1336.833	.021	.8849
AoA x Recency	1	31430.886	31430.886	.502	.4844
Error	28	1752605.187	62593.042		

Table 10: Two way (AoA x Recency) within-participants analysis of variance for naming accuracy.

Source of Variation	*df*	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	29	124.842	4.305			
AoA	1	5.208	5.208	4.866	.0355	
Error	29	31.042	1.070			1.00
Recency	1	3.675	3.675	4.940	.0342	
Error	29	21.575	.744			1.00
AoA x Recency	1	1.008	1.008	.785	.3828	
Error	29	37.242	1.284			1.00

Analysis by Items There were no main effects in the accuracy data in a two way analysis of variance (see Table 11), nor was there a significant interaction (F_2 (1,28) = .20 p = .7) between early (mean = 24, s.d. = 5.44) and late acquired celebrities (mean = 23, s.d. = 6.68), F_2(1,28) = 1.02, p = .3; or between recent (mean = 25.88, s.d. = 1.73) and not recently encountered celebrities (mean = 25.25, s.d. = 3.50) F_2 (1,28) = .72 p = .4.

Table 11: Two way (AoA x Recency) between-items analysis of variance for naming accuracy.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
AoA	1	19.531	19.531	1.023	.3204
Recency	1	13.781	13.781	.722	.4027
AoA x Recency	1	3.781	3.781	.198	.6597
Error	28	534.375	19.085		

The *post hoc* rating scores from participants in this Experiment were collapsed into a mean score for each category and appear in Table 12.

Table 12: Mean *post hoc* rating scores

	Fam	Dist.	AoA	Rec.
Early AoA, Recent	**5.72**	**4.31**	**5.20**	**5.60**
s.d	.77	.93	.34	.33
Early AoA, Not Recent	**4.88**	**4.49**	**4.45**	**4.66**
s.d	1.01	1.01	.69	.54
Late AoA, Recent	**5.55**	**4.64**	**6.65**	**5.79**
s.d.	.71	.94	.37	.51
Late AoA, Not Recent	**5.25**	**4.49**	**5.81**	**5.28**
s.d.	.84	.96	1.36	.70

Key. AoA = Fam. = familiarity, Dist = Distinctiveness, Age of acquisition, Rec. Recency of encounter.

The battery of *t* tests on the *post hoc* ratings scores did not confirm the validity of the experimental groups. The results of the *t*-tests are shown in Table 13 below and the mean *post hoc* ratings for each item appear in Table 8

Table 13: *Post hoc* statistical differences between the four groups.

Categories	Fam	Dist	AoA	Rec.
Recent				
Early vs Late AoA	n.s.	n.s.	$t = 7.46, p < .001$	n.s.
Not recent				
Early AoA vs. Late AoA,	n.s.	n.s.	$t = 3.04, p < .01$	$\mathbf{t = 2.10, p < .04}$
Early AoA				
Recent vs. Not Recent.	$\mathbf{t = 1.9, p < .05}$	n.s.	$\mathbf{t = 3.01, p < .01}$	$t = 4.28, p < .002$
Late AoA,				
Recent vs. Not Recent.	n.s.	n.s.	$\mathbf{t = 1.85, p = .05}$	$t = 1.94, p < .05$

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of Acquisition; Rec. = Recency of encounter. The figures in bold type show the significant differences that confound stimulus groups.

2.4.2.iv Discussion

There were no main effects in the naming latency data, although there was a borderline interaction. There were main effects of AoA and recency of encounter in the accuracy data which suggested that participants were more accurate to produce names to celebrities' faces if they were rated as acquired late in life or if they had been recently encountered. However, the *post hoc* ratings did not validate the experimental groups. Therefore, it is impossible to draw any firm conclusions from this experiment.

Recency of encounter clearly warrants investigation. However, manipulating it as a variable has proved to be extremely difficult, because it is dependent on the individual participants' preferences. It is possible that the scale developed here for recency of encounter was not adequate. However, as recency of encounter is not the focus of this research and will be excluded from further studies.

The effect of recency of encounter in Experiment 1 would have been reduced because participants were required to provide ratings prior to face naming. Furthermore, it will be shown in Chapter 3 (Experiment 4) that an effect of AoA is apparent even on the first presentation of faces to be named. If it is assumed that multiple encounters eliminate the effect of recency Experiment 4 suggests that recency of encounter is not confounded with AoA in the experiments reported in later chapters.

It can be concluded that the stimulus sets were not adequate for the manipulation of two variables. Further analyses will attempt to isolate two larger groups of items that differ in ratings of AoA but not for the other variables. It will be of primary importance that such measures of AoA are consistent across participant groups.

APPENDIX 2.4.3: FACTORIAL MANIPULATION OF AGE OF ACQUISITION ON SELECTED DATA FROM EXPERIMENT 1.

2.4.3.i Introduction

The two attempts at manipulating AoA and other variables were not successful. Where an advantage occurred for speed or accuracy of response, the advantage was for late acquired celebrities. However, it was clear that the *post hoc* ratings for both experiments (Experiment 2.4.1 and Experiment 2.4.2) failed to validate the selection of items in the experimental groups. The differences in *post hoc* ratings gave a significant advantage to late acquired celebrities on both occasions. This Experiment (2.4.3) was devised to investigate and validate the advantage for early acquired items indicated by the results from Experiment 1

2.4.3.ii Method

For this analysis a proportion of stimuli from Experiment 1 were isolated by the following method. Celebrities that had received the highest number of correct (full name) responses were isolated and mean scores derived. Items receiving the maximum number of correct responses were manipulated into two sets of AoA groups (early and late) where familiarity, distinctiveness, surname frequency and phoneme length were matched. Therefore, 40 items created two distinct categories with 20 celebrities in each group. The naming latencies were derived from twenty-four participants who had correctly named the most celebrities in Experiment 1.

Participants The data of 24 participants from Experiment 1 (10 male and 14 female) were isolated (mean = 19.54 years, s.d =2.31).

Materials and Apparatus The rating scores of the 40 items from the 24 participants were extracted from Experiment 1. Mean scores were calculated for each attribute (familiarity, distinctiveness and AoA). Log (x + 1) surname frequency and phoneme length were also matched. Two distinct AoA groups were formed, (early and late). The battery of one tailed *t tests* revealed a significant difference between early and late AoA $t(2,36) = 13.13$, $p<.0001$. No differences occurred between the other attributes, the mean scores appear in Table 1 and the individual scores appear in Table 2.

Table 1 : Mean scores for the early vs. late age of acquisition.

	Fam.	Dist.	AoA	Frequ.	Phoneme
Early age of acquisition	**5.49** ns	**3.98** ns	**4.27***	**1.19** ns	**9.15** ns
s.d.	.72	.95	.56	.87	1.46
Late age of acquisition	**5.42**	**3.48**	**5.97**	**.95**	**10.25**
s.d.	.68	.97	.40	.75	1.80

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x +1) surname frequency, Phoneme. = Phonemes in the full name, RT = Reaction times, CR = number of accurate responses, * = significant $p<.0001$; n.s. = not significant.

Design This was a one factor within-participants, between-items design with two levels of AoA (early vs. late). Naming latency was the dependent variable. Accuracy of response was not applicable as a high proportion of correct responses was the criterion for data inclusion.

Table 2: Individual mean scores for the experimental groups.

Early AoA	Fam.	Dist	AoA	Frequ.	RT	CR
D. Bellamy	5.55	5.00	3.74	1.11	1144	22
C. Chaplin	4.44	5.09	3.79	.78	1276	17
S. Connery	5.45	4.13	4.62	.3	1273	18
T. Cooper	4.43	4.84	4.12	2.43	1267	10
M. Crawford	4.54	2.39	4.47	1.74	1573	13
P. Daniels	5.71	3.38	3.91	1.85	1081	23
L. Dawson	5.35	5.15	4.42	2.18	1252	14
K. Dodd	5.42	5.74	3.97	1.77	1309	18
M. Foot	6.63	4.22	5.34	.40	1444	11
B. Geldoff	5.15	4.00	5.13	0	1263	14
R. Harris	5.87	4.46	3.39	2.22	1246	17
P. McCartney	5.82	2.94	3.96	0	1029	22
J. McEnroe	5.24	2.91	4.55	.25	1408	23
R. Moore	4.45	4.06	4.64	2.36	1252	14
D. O'Conner	4.68	2.39	4.63	1.74	1428	11
E. Rantzen	5.84	4.43	4.61	0	1221	18
R. Reagan	6.07	3.57	4.94	1.48	1248	22
C. Richard	6.11	2.95	3.81	1.92	1182	19
J. Saville	6.2	3.87	3.26	.48	1115	17
M. Thatcher	6.85	4.36	4.15	.78	825	24
mean scores	**5.49**	**3.98**	**4.27**	**1.19**	**1242**	**14.46**
s.d.	0.72	0.95	0.56	0.87	228	2.50

Late AoA	Fam	Dist	AoA	Frequ	RT	CR
R. Atkinson	6.46	5.71	5.45	1.99	1217	18
B. Becker	3.97	2.78	6.20	.48	1904	13
J. Cleese	6.10	3.71	4.81	0	1533 ?	15 ?
B. Clinton	5.73	2.23	5.75	.9	1559	18
R. Branson	5.64	3.90	5.51	.7	1369	21
C. Crawford	4.86	4.27	6.47	1.74	1790	14
J. Donovan	5.56	2.87	5.87	1.11	1324	21
H. Enfield	5.40	2.31	6.38	.14	1492	13
M. Gibbson	5.37	3.46	6.03	2.14	1203	17
A. Hopkins	5.50	3.01	6.03	1.75	1604	15
I. Lendl	4.84	3.32	5.62	0	1526	15
J. Major	6.87	2.76	6.26	.95	1033	22
K. Minogue	5.20	2.81	5.84	.25	1155	23
S. O'Conner	4.76	4.83	6.07	1.74	1109	19
L. Pavarotti	6.07	5.2	6.26	0	1511	24
M. Pfeifer	4.97	4.36	6.04	0	1556	15
K. Reeves	4.47	3.21	6.45	1.57	1246	13
J. Ross	5.71	3.07	6.07	1.88	1303	19
T. Slattery	5.25	2.3	6.31	.95	1312	15
P. Swayze	5.63	3.42	5.87	0	1248	18
mean scores	**5.42**	**3.48**	**5.97**	**0.91**	**1399**	**17.40**
s.d	0.68	0.97	0.40	0.78	226.10	3.50

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x +1) surname frequency, Phoneme. = Phonemes in the full name, RT = Reaction times, CR = number of accurate responses, * = significant $p<.0001$; n.s. = not significant.

2.4.3.iii Results

The overall mean naming latencies for the accurate responses for the 40 celebrities was calculated. The mean naming latency of all correct responses was 1320 msec. (s.d. = 210 msec.).

Analysis by Participants There was significant effect of AoA $F_1(1,23) = 8.24$, $p<.009$, in a one way analysis of variance (see Table 3) between early (mean = 1242 msecs, s.d. = 228 msecs) and late AoA (mean = 1391 msecs., s.d. = 361 msecs). Participants were faster to name to celebrities rated as acquired early in life than they were to name celebrities rated as late acquired, the individual mean scores appear in Table 5.

Table 3: Analysis of variance on participants' reaction time data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	3443940.710	149736.553			
Age of acquisition	1	267490.359	267490.359	8.244	.0086	
Error	23	746265.410	32446.322			1.00

Analysis by Items There was a significant effect of AoA in a one way analysis of variance (see Table 4) between early (mean = 1242 msec., s.d. = 162 msec) and late AoA (mean = 1399 msec., s.d. = 226 msec) $F_2(1,38)= 6.41$, $p<.02$. Celebrities rated as acquired early in life were named faster than were celebrities rated as acquired late in life.

Table 4: Analysis of variance on reaction time data for items.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
Age of acquisition	1	247299.213	247299.213	6.405	.0156
Error	38	1467210.267	38610.796		

Table 5: Participants' reaction times and accuracy data.

	Early Acquired		Late Acquired	
Participants	**RT**	**CR**	**RT**	**CR**
1	1205	17	1079	17
2	1609	13	1478	16
3	932	17	1236	18
4	981	14	1319	13
5	1277	11	1504	10
6	1045	16	1390	18
7	1458	13	1477	16
8	1320	11	1579	13
9	1449	11	1370	11
10	1420	12	2349	13
11	1724	13	2315	13
12	1053	17	1099	15
13	1373	15	1476	14
14	931	20	1114	15
15	940	17	941	19
16	1036	13	1088	14
17	1071	17	1145	16
18	1207	14	1191	8
19	1301	12	1097	11
20	1285	17	1474	20
21	1582	13	1943	13
22	1118	15	1309	18
23	1096	17	1186	14
24	1397	12	1237	13
mean scores	**1242.**	**14.46**	**1392**	**14.50**
s.d.	228	2.50	361	3.00

Key: RT = reaction time (in millisecond), CR = The number of accurate responses.

2.4.3.iv Discussion

In the analysis of the two AoA groups there was a significant difference between naming latencies for early and late acquired celebrities. Celebrities rated as acquired early in life were named faster than were celebrities rated as late acquired. As the data were selected on the basis of a high proportion of correct responses, therefore, analyses of the accuracy data would not be appropriate.

The next step was to replicate these results using the paradigm from Experiment 1. Importance will be given to the ratings acquired from different participants in order to validate the experimental groups.

APPENDIX 2.4.4: FACTORIAL REPLICATION OF EARLY AND LATE AGE OF ACQUISITION.

2.4.4.i Method

Participants Twenty four undergraduate students (13 male, 11 female) from Durham University participated in this experiment (mean age = 19.25 years, s.d. = 1.94) and were paid £3 for completing the experimental tasks.

Materials The materials were reported in the previous experiment. The table showing the mean scores and statistical differences between the groups is re-produced below as Table 1. The individual mean scores appear in Table 8.

Table 1 : Mean scores for the early vs. late age of acquisition.

	Fam.	Dist.	AoA	Frequ.	Phoneme
Early age of acquisition	**5.49** ns	**3.98** ns	**4.27***	**1.19** ns	**9.15** ns
s.d.	.72	.95	.56	.87	1.46
Late age of acquisition	**5.42**	**3.48**	**5.97**	**.95**	**10.25**
s.d.	.68	.97	.40	.75	1.80

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition; Frequ. = Log (x +1) surname frequency, Phoneme. = The number of phonemes in the full name, * = significant difference $p<.0001$; n.s. = not statistically significant.

Apparatus and Procedure Celebrity images, presentation and method of response collection were described for Experiment 1. As with Experiment 1, participants were given instructions and introductory practice trials for each task, the data from which was excluded from all analysis. Participants first rated all the 40 images for familiarity, distinctiveness and AoA. Following a short break participants attempted to name the celebrities' faces as quickly and accurately as possible. The faces were presented in a different random order on each presentation. The experiment and rating tasks lasted for approximately 30 minutes following which participants were debriefed.

Design This was a within-participants, between-items one factor design with two levels of AoA (early vs. late). Naming latency and accuracy of response were the dependent variables.

2.4.4.ii Results

Mean naming latencies of correct responses for the 40 celebrity faces were calculated. The overall mean naming latency was 1453 msec. (s.d. = 673 msec). The mean number of correct responses was 13.67 (s.d. = 2.85). A skew in the naming latencies was reduced (from 1.45 to 0.13) with a reciprocal transformation.

Naming Latency

Analysis by Participants There was no significant difference between early (mean = 1289 msec.; s.d. = 405 msec.) and late AoA (mean = 1402 msec.; s.d. = 542 msec.) in a one way analysis of variance (see Table 2) $F_1(1,24) = .37$, $p = .6$. The mean scores of participants' data appear in Table 3.

Table 2: Analysis of variance on participants' reaction time data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	5784758.966	251511.259			
Age of acquisition	1	20757.153	20757.153	.366	.5512	
Error	23	1304691.302	56725.709			1.00

Table 3: **Participants' reaction time and accuracy data.**

	Early Acquired		Late Acquired	
Participants	**RT**	**CR**	**RT**	**CR**
1	1476	9	1692	12
2	2264	12	1815	14
3	1288	14	1604	12
4	1659	11	1952	11
5	1160	15	1295	15
6	1379	15	1141	10
7	1051	14	1158	12
8	1516	12	1373	13
9	1144	16	1447	16
10	1457	16	1530	16
11	1280	13	1190	14
12	1074	12	1447	13
13	1822	14	2881	12
14	1379	16	1903	15
15	1078	16	1250	13
16	1091	14	935	15
17	1621	13	1276	15
18	1078	14	928	15
19	1002	13	867	15
20	1053	11	984	15
21	1458	16	1256	15
22	1408	13	1253	15
23	1961	12	1529	9
24	882	16	876	16
mean scores	**1289**	**13.65**	**1402**	**13.67**
s.d.	405	3.95	542	2.48

Key RT = reaction time (in millisecond), CR = The number of accurate responses.

Analysis by Items There was a significant difference between early (mean = 1242 msec.; s.d. = 161 msecs.) and late AoA (mean = 1399 msec.; s.d. = 226 msec) in a one way analysis of variance (see Table 4) $F_2(1,38) = .6.45$ $p < .02$.

Table 4: Analysis of variance on reaction time data for item.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
Age of Acquisition	1	249324.100	249324.100	6.447	.0153
Error	38	1469493.400	38670.879		

Accuracy

Analysis by Participants There was no significant difference in the accuracy data between early (mean = 13.65, s.d. = 3.95) and late AoA (mean = 13.67, s.d. = 2.48) in a one way analysis of variance (see Table 5), $F_1(1,23) = .01$, $p = .9$.

Table 5: Analysis of variance on participants accuracy data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	121.479	5.282			
Age of acquisition	1	.021	.021	.009	.9240	
Error	23	51.479	2.238			1.00

Analysis by Items There was no significant difference in the accuracy data between early (mean = 17.35, s.d. = 4.38) and late AoA (mean = 17.40, s.d. = 3.46) in a one way analysis of variance (see Table 6) $F_2(1,38) = .02$, $p = 1$.

Table 6: Analysis of variance on the accuracy data, by items .

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*
Age of Acquisition	1	.025	.025	.002	.9682
Error	38	591.350	15.562		

Post hoc Ratings

Post hoc ratings did not confirm the validity of the *a priori* measures for familiarity, $t(2,36) = 2.40$, $p<.02$. There was a significant advantage of rated familiarity for celebrities rated as *late* acquired. The allocation of stimuli to groups of early and late acquired items was validated $t(2,36) = 8.41$, $p<.0001$. The mean attribute scores and the results of paired *t* tests appear in Table 7 and the individual data appear in Table 8.

2.4.4.iii Discussion

The *post hoc* familiarity ratings were biased in favour of *late* AoA, yet the non significant trend in the difference in latency (113 msec.) was to the advantage of *early* AoA. A close inspection of the familiarity scores revealed that two celebrities from the early AoA group had extremely low familiarity ratings (Tommy Cooper mean rating = 2.92 and Michael Foot mean rating = 2.20). In light of the these findings a further subset of celebrities were isolated on the basis of high familiarity ratings for analysis and replication. Experiments based on the this further selection of stimuli are reported in Chapters 3 to 5 of this thesis.

Table 7: The mean *post hoc* ratings scores.

	Fam.	**Dist.**	**AoA**
Early age of acquisition	**4.61 ***	**3.98 n.s.**	**4.45****
s.d.	1.15	.95	.54
Late age of acquisition	**5.26**	**3.48**	**5.69**
s.d.	.72	.97	.43

Key Fam. = Familiarity, Dist. = Distinctiveness, AoA = age of acquisition.

Table 8: *A priori* and *post hoc* ratings for the experimental groups

Early Age of Acquisition

	A priori Ratings					*Post hoc Ratings*		
	Fam	**Dist**	**AoA**	**Frequ.**	**Phme**	**Fam**	**Dist**	**AoA**
J. Saville	6.20	3.87	3.26	.48	9	5.00	4.61	3.84
E. Rantzen	5.84	4.43	4.61	0	10	4.84	2.30	5.04
M. Thatcher	6.85	4.36	4.15	.78	10	6.60	3.55	4.08
S. Connery	5.45	4.13	4.62	.30	9	5.64	3.23	4.80
R. Harris	5.87	4.46	3.39	2.22	9	5.60	3.79	4.24
D. O'Conner	4.68	2.39	4.63	1.74	8	3.20	3.01	4.68
M. Crawford	4.54	2.39	4.47	1.74	11	3.48	3.94	5.16
T. Cooper *	**4.43**	**4.84**	**4.12**	**2.43**	**8**	**2.92 ***	**3.23**	**3.76**
D. Bellamy	5.55	5.00	3.74	1.11	11	4.76	2.82	4.44
C. Chaplin	4.44	5.09	3.79	.78	10	4.84	3.10	3.88
P. Daniels	5.71	3.38	3.91	1.85	10	5.04	2.99	4.48
L. Dawson	5.35	5.15	4.42	2.18	8	3.72	4.92	4.80
K. Dodd	5.42	5.74	3.97	1.77	6	3.16	2.70	4.48
B. Geldoff	5.15	4.00	5.13	0	9	4.48	3.14	5.36
M. Foot *	**6.63**	**4.22**	**5.34**	**.40**	**8**	**2.20 ***	**2.07**	**3.16**
P. McCartney	5.82	2.94	3.96	0	10	5.32	2.42	4.64
J. McEnroe	5.24	2.91	4.55	.25	10	4.68	4.40	4.60
R. Moore	4.45	4.06	4.64	2.36	6	5.20	3.86	4.76
R. Reagan	6.07	3.57	4.94	1.48	11	5.72	3.58	4.84
C. Richard	6.11	2.95	3.81	1.92	10	5.88	3.08	4.00
mean scores	**5.49**	**3.98**	**4.27**	**1.19**	**9.15**	**4.61**	**3.35**	**4.45**
s.d.	0.72	0.95	0.56	0.87	1.46	1.15	0.77	0.54

Late Age of Acquisition

	A priori Ratings					*Post hoc Ratings*		
	Fam	**Dis.**	**AoA**	**Frequ**	**Pheme**	**Fam**	**Dist**	**AoA**
R. Atkinson	6.46	5.71	5.45	1.99	12	6.08	5.01	5.63
B. Becker	3.97	2.78	6.20	.48	9	4.54	1.94	5.33
J. Cleese	6.10	3.71	4.81	0	7	5.13	4.45	4.88
B. Clinton	5.73	2.23	5.75	.9	10	5.54	2.76	6.17
R. Branson	5.64	3.90	5.51	.7	12	5.33	1.99	5.83
C. Crawford	4.86	4.27	6.47	1.74	11	5.63	3.21	5.96
J. Donovan	5.56	2.87	5.87	1.11	12	5.46	3.50	5.50
H. Enfield	5.40	2.31	6.38	.14	11	4.50	3.17	6.13
M. Gibbson	5.37	3.46	6.03	2.14	9	5.67	3.05	5.71
A. Hopkins	5.50	3.01	6.03	1.75	13	4.92	3.28	6.08
I. Lendl	4.84	3.32	5.62	0	10	3.58	3.32	4.58
J. Major	6.87	2.76	6.26	.95	7	6.83	3.32	6.04
K. Minogue	5.20	2.81	5.84	.25	9	5.88	3.39	5.25
S. O'Conner	4.76	4.83	6.07	1.74	8	4.21	2.50	5.96
L. Pavarotti	6.07	5.20	6.26	0	14	5.67	4.85	5.67
M. Pfeifer	4.97	4.36	6.04	0	9	5.21	3.34	5.89
K. Reeves	4.47	3.21	6.45	1.57	8	5.79	4.45	6.17
J. Ross	5.71	3.07	6.07	1.88	10	4.79	3.84	5.96
T. Slattery	5.25	2.30	6.31	.95	11	4.92	3.65	5.54
P. Swayze	5.63	3.42	5.87	0	11	5.46	2.18	5.54
mean scores	**5.42**	**3.48**	**5.97**	**0.91**	**10**	**5.26**	**3.36**	**5.69**
s.d	0.68	0.97	0.40	0.78	2.27	0.72	0.83	0.43

Key: Fam. = Familiarity, Dist. = Distinctiveness, AoA = Age of acquisition, Frequ. = Log (x+1) surname frequency, RT = Reaction times in milliseconds, CR = the number of accurate responses.

EXPERIMENT 2

APPENDIX 3.2.i: Factorial anlysis of selected data from Experiment 1.

	Early Age of Acquisition		Late Age of Acquisition	
	R.T.	C.R.	R.T.	C.R.
1	1304	23	1807	23
2	1298	20	1463	16
3	1745	20	1560	19
4	1256	24	1095	22
5	1060	21	1493	19
6	1230	20	1359	17
7	1099	23	1249	24
8	1192	21	1458	17
9	1350	19	1642	15
10	1442	17	1613	18
11	1346	14	1616	13
12	1747	17	2017	13
13	978	23	1211	24
14	1145	23	1405	21
15	1152	23	1189	23
16	1493	11	1965	8
17	1072	23	1148	21
18	1078	20	1072	19
19	994	23	1021	24
20	1262	25	1609	21
21	1015	24	1069	23
22	1491	24	1370	20
23	1123	24	1158	23
23	1213	22	1562	18
24	1278	21	1296	17
25	1893	12	1476	13
26	1588	9	1629	6
27	1545	17	1743	18
28	1022	23	1310	23
29	1285	15	1601	13
30	1155	15	1332	16
Mean Scores	**1298**	**19.63**	**1447**	**18.20**
s.d.	235	4.50	257	4.69

Key R.T. = reaction times in milliseconds, CR = The number of correct responses.

Appendix 3.2.ii: Analysis of variance on participants' naming latencies for Experiment 2

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	29	2926866.480	100926.430			
AoA	1	354355.350	354355.350	16.759	.0003	
Error	29	613193.150	21144.591			1.00

Appendix 3.2.iii: Analysis of variance on participants' naming accuracy for Experiment 2 .

Source of Variation	df	Sum of Squares	Mean Square	*F*	*P*	Epsilon Correction
Participants	29	1119.483	38.603			
AoA	1	36.817	36.817	19.525	.0001	
Error	29	54..683	1.886			1.00

Appendix 3.2.iv: Data for factorial analysis (n=50).

Early AoA	Fam.	Dist.	AoA	Freq.	Phem	R.T.	C.R.
M. Aspel.	5.28	2.38	4.85	0.14	10	1429	19
R. Atkinson.	6.46	5.71	5.45	1.99	12	1309	22
R. Barker.	5.74	4.75	4.06	2.12	8	1853	16
D. Bellamy.	5.55	5.00	3.84	1.11	11	1256	21
C. Black.	6.26	3.84	4.74	1.76	8	1136	28
J. Cleese.	6.10	3.71	4.81	0.70	7	1204	18
J. Collins.	6.08	4.39	4.73	2.23	9	1333	23
P.Collins.	5.82	3.23	5.29	2.23	9	1148	24
S. Connery.	5.45	4.13	4.62	0.30	9	1281	19
M. Crawford.	4.54	2.39	4.47	1.74	11	1473	13
P. Daniels.	5.71	3.38	3.91	1.85	10	1214	29
B. Forsyth.	6.29	4.99	4.20	1.08	9	1245	23
B. Geldoff.	5.15	4.00	5.13	0	9	1297	17
Rolf Harris.	5.87	4.46	3.39	2.22	9	1291	21
M. Jackson.	6.68	5.33	4.58	2.74	11	939	29
L. Dennis.	4.80	2.19	5.36	1.36	8	1343	14
P. McCartney.	5.82	2.94	3.96	0	10	1222	24
F. Mercury.	5.78	4.91	5.00	0	12	1311	23
R. Reagan.	6.07	3.55	4.94	1.48	11	1194	25
C. Richard.	6.11	2.93	3.81	1.92	10	1277	24
J. Saville.	6.20	3.87	3.26	0.48	9	1131	22
D. Spencer.	6.78	3.65	4.51	2.01	11	1251	27
M. Thatcher.	6.85	4.36	4.15	0.78	10	883	30
T. Wogan.	6.27	3.00	4.20	0.14	9	1125	24
V. Wood.	4.50	2.20	5.38	2.56	12	1373	22
mean scores	**5.85**	**3.81**	**4.51**	**1.32**	**9.76**	**1261**	**22.28**
s.d.	.63	1.00	.61	.89	1.36	180	4.52

Late AoA	Fam.	Dist.	AoA	Freq.	Phem	R.T.	C.R.
W. Allen.	5.17	4.72	5.55	2.36	8	1135	23
R. Branson.	5.64	3.90	5.51	0.70	12	1627	21
G. Bush.	6.06	2.74	5.98	1.00	6	1523	18
B. Clinton.	5.73	2.23	6.65	0.90	10	1462	17
J. Donovan.	5.56	2.87	5.87	1.11	12	1349	26
B. Elton.	5.55	2.82	6.01	0.60	8	1416	26
H. Enfield.	5.40	2.31	6.38	0.14	11	1466	15
C. Evans.	5.56	4.20	6.76	2.57	9	1162	11
S. Ferguson.	6.15	2.68	5.68	1.73	12	1418	10
S. Fry.	5.97	4.41	5.94	.78	8	1858	20
M. Gibson.	5.37	3.46	6.03	2.13	9	1236	18
M. Gorbachev.	5.11	3.54	5.84	0	13	1410	16
A. Hopkins.	5.05	3.01	6.03	1.75	13	1725	16
M. Hestltine.	5.88	4.92	5.68	0	13	1391	17
I. Hyslop.	5.64	3.55	6.52	0.70	9	1436	14
C. James.	5.90	4.23	5.71	2.05	8	1514	19
J. Major.	6.87	2.76	6.26	0.95	7	1081	29
K. Minogue.	5.20	2.81	5.84	0.25	9	1250	28
V. Reeves.	5.26	3.23	6.40	1.57	7	1324	16
M. Palin.	5.91	3.16	5.60	1.36	10	1287	22
L. Pavarotti.	6.07	5.20	6.26	0	14	1516	10
J. Ross.	5.71	3.07	6.07	1.88	10	1395	22
T. Slattery.	5.25	2.30	6.31	0.95	11	1266	15
J. Smith.	5.53	2.21	6.59	3.06	7	1253	20
P. Swayze.	5.63	3.42	5.87	0	11	1254	21
mean scores	**5.65**	**3.35**	**6.05**	**1.14**	**9.88**	**1390**	**18.80**
s.d.	.41	.86	.36	.88	2.24	180	5.17

Key

Fam = Familiarity
Dist. = Distinctiveness
AoA = Age of acquisition
Freq. = Surname (x+1) frequency
Phem. = Phonemes in full name,
R.T. = reaction time in milliseconds
CR = accurate scores out of 25.

Experment 3

Appendix 3.3.i: Participants' naming latency and accuracy data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	**R.T.**	**CR**	**R.T.**	**CR**
1	1993	21	2200	17
2	1492	17	1765	15
3	1382	13	1840	10
4	2007	16	2177	14
5	1372	19	1814	12
6	1105	19	1589	17
7	1456	10	1636	13
8	742	19	778	13
9	1304	22	1509	21
10	1714	22	2156	18
11	1685	14	2404	11
12	1122	18	1253	19
13	938	21	1125	21
14	1360	20	1873	19
15	1327	16	1377	17
16	998	22	1065	23
17	1169	19	1319	18
18	1321	10	1631	10
19	1275	12	1384	10
20	1262	15	1433	14
21	1156	17	1219	17
22	1362	20	1510	11
23	1013	22	1086	20
24	892	20	931	23
Means	**1310**	**17.67**	**1545**	**15.96**
s.d.	314	3.73	426	4.14

R.T. = reaction times in milliseconds, Accuracy = accurate scores out of 25.

Appendix 3.3.ii: Analysis of variance for participants' naming latencies.

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	6053421.195	263192.226			
AoA	1	659449.246	659449.246	39.424	.0001	
Error	23	384725.613	16727.201			1.00

Appendix 3.3.iii: Analysis of variance for participants' accuracy data.

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	618.813	26.905			
AoA	1	35.021	35.021	8.436	.0080	
Error	23	95.479	4.151			1.00

Appendix 3.3.iv: Mean *post hoc* rating scores, naming latency and accuracy data for Experiment 3.

Early AoA	Fam.	Dist.	AoA	R.T.	C.R.
M. Aspel.	4.59	2.39	4.96	1216	15
R. Atkinson.	6.10	5.23	5.42	1580	16
R. Barker.	4.52	4.61	4.32	1274	6
D. Bellamy.	5.23	5.23	3.93	1174	15
C. Black.	6.03	3.42	4.57	957	24
J. Cleese.	5.33	3.48	4.72	1413	17
J. Collins.	5.10	4.58	4.60	1534	17
P.Collins.	4.87	2.90	5.07	1451	18
S. Connery.	5.57	4.55	4.27	1284	16
M. Crawford.	3.48	2.48	4.29	1603	8
P. Daniels.	5.50	3.39	4.23	1536	20
B. Forsyth.	5.80	4.84	4.50	1719	21
B. Geldoff.	3.33	3.35	5.33	1432	10
Rolf Harris.	5.43	4.55	3.77	1631	18
M. Jackson.	6.55	5.81	4.32	828	22
L. Dennis.	4.13	2.52	5.19	1548	14
P. McCartney.	4.97	3.65	4.50	1291	15
F. Mercury.	5.30	4.29	4.75	1240	16
R. Reagan.	6.06	3.42	4.77	1260	17
C. Richard.	5.69	3.23	4.33	1277	20
J. Saville.	5.33	3.74	3.53	1567	17
D. Spencer.	6.68	4.52	4.26	954	24
M. Thatcher.	6.55	4.61	3.94	899	21
T. Wogan.	5.43	2.97	4.38	1032	20
V. Wood.	4.04	2.19	5.32	1356	17
mean scores	**5.26**	**3.84**	**4.53**	**1322**	**16.96**
s.d.	.89	.99	.49	247	4.37

Late AoA	Fam.	Dist.	AoA	R.T.	C.R.
W. Allen.	4.19	4.29	5.68	1887	15
R. Branson.	5.23	4.45	5.32	1396	15
G. Bush.	5.67	2.87	5.52	1665	17
B. Clinton.	5.48	2.45	6.21	1510	15
J. Donovan.	4.89	2.71	5.31	1227	21
B. Elton.	5.33	2.74	5.74	1654	19
H. Enfield.	4.84	2.10	6.05	2406	11
C. Evans.	5.93	4.74	6.46	1284	17
S. Ferguson.	5.70	2.39	5.50	1686	20
S. Fry.	5.53	4.42	5.62	1316	13
M. Gibson.	5.81	3.65	5.46	1302	18
M. Gorbachev.	4.85	3.61	5.41	1679	17
A. Hopkins.	4.67	2.81	5.63	1777	9
M. Hesteltine.	5.62	3.39	5.41	1749	17
I. Hyslop.	5.41	3.68	6.43	1824	7
C. James.	5.47	3.97	5.33	1432	8
J. Major.	6.71	3.58	6.00	1070	22
K. Minogue.	5.39	4.00	5.26	1028	21
V. Reeves.	5.12	3.19	6.27	1890	14
M. Palin.	4.35	3.10	5.30	1159	13
L. Pavarotti.	5.16	5.48	5.81	1048	20
J. Ross.	5.10	2.90	5.68	1615	18
T. Slattery.	4.83	2.48	5.90	1935	15
J. Smith.	3.94	2.52	6.11	1403	6
P. Swayze.	5.53	3.58	5.53	1511	15
mean scores	**5.23**	**3.40**	**5.72**	**1538**	**15.32**
s.d.	.59	.85	.37	329	4.44

Key:
Fam = Familiarity,
Dist. = Distinctiveness
AoA = Age of acquisition,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.

Appendix 3.4.i: Mean scores of participants' data in four blocks Experiment 4 .

Early Age of Acquisition

	Block 1		Block 2		Block 3		Block 4	
	R.T.	**C.R.**	**R.T.**	**C.R.**	**R.T.**	**C.R.**	**R.T.**	**C.R.**
1	1425	11	1352	18	1258	20	1243	21
2	1556	15	1644	21	1201	23	1281	25
3	1477	18	1534	19	1094	23	1184	25
4	1176	23	1155	25	826	25	1064	24
5	1039	8	1154	20	1076	23	1234	23
6	1821	14	1441	18	1286	20	1373	23
7	1724	19	1853	22	1092	23	1097	22
8	2210	13	2424	15	1257	21	1814	21
9	2184	10	1909	19	1673	18	1477	20
10	1755	22	1938	24	1163	23	1254	23
11	1462	8	1771	15	1474	17	2016	18
12	1250	13	1628	19	1044	24	1101	23
13	1955	15	2063	18	1400	23	1481	22
14	1676	11	1865	15	1659	16	1432	17
15	1415	22	1786	23	1162	21	1126	24
16	1315	8	1921	17	1613	21	1570	23
17	1351	12	1380	18	1043	19	1371	22
18	1435	9	1410	12	1230	19	1510	20
19	1132	12	1341	19	996	22	955	19
20	1319	13	1629	18	1123	22	1309	24
21	1469	23	1529	25	1150	25	1164	25
22	1227	9	1539	15	1293	19	1611	20
23	1665	12	1277	13	1098	15	1156	18
24	1594	9	1580	18	1039	19	1179	20
Means	**1526**	**13.71**	**1219**	**18.58**	**1116**	**20.88**	**1073**	**21.75**
s.d.	305	4.95	214	3.50	221	2.72	208	2.35

Late Age of Acquisition

	R.T.	**C.R.**	**R.T.**	**C.R.**	**R.T.**	**C.R.**	**R.T.**	**C.R.**
1	1288	7	1219	15	1094	18	1125	21
2	1076	13	1221	19	1084	23	1037	23
3	955	14	1281	21	1002	24	1156	25
4	796	15	811	23	885	21	794	24
5	1096	9	1139	20	1009	24	1165	23
6	1260	13	1153	21	1274	23	1131	24
7	818	13	881	21	795	23	958	24
8	1495	9	2090	19	1482	22	1374	22
9	1178	11	1563	18	1450	19	1187	20
10	905	16	1217	23	995	24	982	23
11	1344	9	1279	16	1134	17	1229	16
12	930	14	990	20	882	19	993	21
13	1294	9	1476	10	1127	15	1789	19
14	1544	9	1165	14	1385	13	1640	18
15	986	20	1036	20	876	21	1001	22
16	1167	12	1110	17	992	21	896	22
17	1034	8	1071	14	850	19	1113	23
18	1517	7	1404	16	1386	17	1291	22
19	870	18	1042	17	769	19	943	20
20	967	12	1179	19	967	23	1131	22
21	1055	23	1037	24	1027	25	985	24
22	1163	5	1459	12	1316	15	1453	17
23	1195	8	971	18	967	19	932	19
24	840	10	1124	17	993	11	1120	18
Means	**1630**	**11.83**	**1334**	**18.08**	**1205**	**19.79**	**1143**	**21.33**
s.d.	305	4.36	249	3.49	263	3.74	234	2.46

R.T. = reaction times in milliseconds, Accuracy = accurate scores out of 25.

Appendix 3.4.ii: Table showing a two way analysis of variance for AoA by Block on participants' naming latencies.

Source of Variation	d.f.	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	7113417.676	309279.029			
AoA	1	4125429.607	4125429.607	91.326	.0001	
Error	23	1038964.290	45172.360			1.00
Block	3	1938718.507	646239.502	23.425	.0001	
Error	69	1903570.840	27587.983			.84
AoA x Block	3	760014.412	253338.137	10.529	.0001	
Error	69	1660221.663	24061.184			.75

Appendix 3.4.iii: Table showing a two way analysis of variance for AoA by Block on participants' accuracy data.

Source of Variation	d.f.	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	1532.370	66.625			
AoA	1	1392.130	1392.130	121.172	.0001	
Error	23	264.245	11.489			1.00
Block	3	607.682	202.561	47.875	.0001	
Error	69	291.943	4.231			.83
AoA x Block	3	231.307	77.102	22.949	.0001	
Error	69	231.818	3.360			.83

Appendix 3.4.iv: Analysis of variance for participants' naming latencies by block.

BLOCK	Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
1	**Participants**	23	3652722.556	158814.024			
	AoA	1	129450.66	129450.066	4.689	.0410	
	Error	23	634942.863	27606.211			1.00
2	**Participants**	23	2045090.702	88916.987			
	AoA	1	158085.346	158085.346	8.548	.0076	
	Error	23	425379.662	18494.768			1.00
3	**Participants**	23	2181604.873	948252.386			
	AoA	1	95613.527	95613.527	4.170	.0528	
	Error	23	527400.575	22930.460			1.00
4	**Participants**	23	1852697.872	80552.081			
	AoA	1	59130.864	59130.864	3.431	.0768	
	Error	23	396335.367	17231.972			1.00

Appendix 3.4.v: Analysis of variance for participants' naming accuracy by block.

BLOCK	Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
	Participants	23	870.979	37.869			
1	**AoA**	1	42.188	42.188	7.504	.0117	
	Error	23	129.313	5.622			1.00
2	**Participants**	23	465.667	20.246			
	AoA	1	3.000	3.000	.719	.4053	
	Error	23	96.000	4.174			1.00
3	**Participants**	23	385.667	16.768			
	AoA	1	14.083	14.083	3.030	.0951	
	Error	23	106.917	4.649			1.00
4	**Participants**	23	238.917	10.388			
	AoA	1	2.083	2.083	1.780	.1952	
	Error	23	26.917	1.170			1.00

Appendix 3.4.vi: Items naming latency data.

		Block 1	Block 2	Block 3	Block 4
Early AoA	M. Aspel.	1498	1690	1438	1113
	R. Atkinson.	1677	1342	1258	1161
	R. Barker.	2764	1531	1217	1225
	D. Bellamy.	2009	1333	1175	1376
	C. Black.	1379	1002	822	866
	J. Cleese.	1779	1459	1458	1466
	J. Collins.	1505	1240	914	910
	P.Collins.	1810	1382	1062	1089
	S. Connery.	1513	1247	1250	1191
	M. Crawford.	3309	1649	1763	1395
	P. Daniels.	1343	1028	993	1066
	B. Forsyth.	1455	1162	1172	1231
	B. Geldoff.	1455	1335	1182	1184
	Rolf Harris.	1305	1285	1208	975
	M. Jackson.	993	773	744	790
	L. Dennis.	1918	1390	1105	1030
	P. McCartney.	1753	1160	1042	911
	F. Mercury.	1643	1064	982	888
	R. Reagan.	1629	1330	1385	1062
	C. Richard.	1356	1029	965	1069
	J. Saville.	1468	1210	991	1000
	D. Spencer.	1164	960	885	978
	M. Thatcher.	1085	834	884	857
	T. Wogan.	1551	1077	1111	972
	V. Wood.	2056	1394	1087	1032
	mean scores	**1657**	**1236**	**1124**	**1074**
	s.d.	498	231	227	174
Late AoA	W. Allen.	1613	1286	1044	985
	R. Branson.	1768	1264	1023	982
	G. Bush.	1456	1331	1356	1289
	B. Clinton.	1781	1125	1360	1192
	J. Donovan.	1546	1007	1280	837
	B. Elton.	1297	1008	1213	1115
	H. Enfield.	2630	1566	1729	1393
	C. Evans.	1281	1207	1033	951
	S. Ferguson.	1625	1258	1100	989
	S. Fry.	1638	1425	1511	1379
	M. Gibson.	1632	1482	1278	1173
	M. Gorbachev.	1944	1257	1112	1132
	A. Hopkins.	2361	2004	1375	1679
	M. Hesteltine.	1332	1231	1120	976
	I. Hyslop.	1823	1546	1113	1278
	C. James.	1384	1768	1851	1672
	J. Major.	1178	1075	854	923
	K. Minogue.	1478	907	846	885
	V. Reeves	1756	1498	1403	1193
	M. Palin.	1738	1224	1257	1212
	L. Pavarotti.	1451	1115	833	788
	J. Ross.	1881	1751	1254	1347
	T. Slattery.	1871	1550	1190	1159
	J. Smith.	2230	1496	1220	1124
	P. Swayze.	2155	1446	1319	1211
	mean scores	**1714**	**1353**	**1227**	**1155**
	s.d.	354	263	244	229

Appendix 3.4.vii: Items accuracy data (accurate scores out of 25).

		Block 1	Block 2	Block 3	Block 4
Early AoA	M. Aspel.	5	12	17	17
	R. Atkinson.	10	18	20	22
	R. Barker.	3	16	17	21
	D. Bellamy.	14	19	22	22
	C. Black.	19	22	23	22
	J. Cleese.	11	16	17	20
	J. Collins.	14	16	23	21
	P.Collins.	17	19	18	20
	S. Connery.	12	15	20	23
	M. Crawford.	4	8	12	12
	P. Daniels.	16	18	21	21
	B. Forsyth.	16	18	19	21
	B. Geldoff.	9	15	19	22
	Rolf Harris.	15	16	22	19
	M. Jackson.	19	22	22	24
	L. Dennis.	6	16	17	16
	P. McCartney.	15	18	22	17
	F. Mercury.	14	16	22	24
	R. Reagan.	15	17	19	20
	C. Richard.	15	20	19	21
	J. Saville.	16	22	20	23
	D. Spencer.	15	24	24	24
	M. Thatcher.	20	22	24	24
	T. Wogan.	18	21	22	23
	V. Wood.	11	20	20	23
	mean scores	**13.16**	**17.84**	**20.04**	**20.88**
	s.d.	4.74	3.52	2.76	2.89
Late AoA	W. Allen.	15	19	23	23
	R. Branson.	14	20	18	22
	G. Bush.	7	14	17	17
	B. Clinton.	12	18	16	21
	J. Donovan.	18	20	23	23
	B. Elton.	9	15	21	20
	H. Enfield.	4	10	12	13
	C. Evans.	15	20	23	24
	S. Ferguson.	10	22	21	24
	S. Fry.	10	8	18	18
	M. Gibson.	10	18	18	21
	M. Gorbachev.	11	21	21	22
	A. Hopkins.	5	7	11	13
	M. Hesteltine.	14	19	19	20
	I. Hyslop.	9	18	18	23
	C. James.	7	15	16	19
	J. Major.	22	22	24	24
	K. Minogue.	14	23	21	24
	V. Reeves.	10	17	19	20
	M. Palin.	11	18	19	21
	L. Pavarotti.	22	23	24	23
	J. Ross.	8	18	18	20
	T. Slattery.	9	15	19	18
	J. Smith.	6	11	14	17
	P. Swayze.	12	23	22	22
	mean scores	**11.36**	**17.36**	**19.00**	**20.48**
	s.d.	4.64	4.55	3.46	3.12

Appendix 3.4 viii *Post hoc* ratings for familiarity, distinctiveness and age of acquisition.

EARLY AGE OF ACQUISITION				LATE AGE OF ACQUISITION			
	Fam.	**Dist.**	**AoA**		**Fam.**	**Dist.**	**AoA**
M. Aspel.	5.28	2.38	4.85	W. Allen.	5.17	4.72	5.55
R. Atkinson.	6.46	5.71	5.45	R. Branson.	5.64	3.90	5.51
R. Barker.	5.74	4.75	4.06	G. Bush.	6.06	2.74	5.98
D. Bellamy.	5.55	5.00	3.84	B. Clinton.	5.73	2.23	6.65
C. Black.	6.26	3.84	4.74	J. Donovan.	5.56	2.87	5.87
J. Cleese.	6.10	3.71	4.81	B. Elton.	5.55	2.82	6.01
J. Collins.	6.08	4.39	4.73	H. Enfield.	5.40	2.31	6.38
P.Collins.	5.82	3.23	5.29	C. Evans.	5.56	4.20	6.76
S. Connery.	5.45	4.13	4.62	S. Ferguson.	6.15	2.68	5.68
M. Crawford.	4.54	2.39	4.47	S. Fry.	5.97	4.41	5.94
P. Daniels.	5.71	3.38	3.91	M. Gibson.	5.37	3.46	6.03
B. Forsyth.	6.29	4.99	4.20	M. Gorbachev.	5.11	3.54	5.84
B. Geldoff.	5.15	4.00	5.13	A. Hopkins.	5.05	3.01	6.03
Rolf Harris.	5.87	4.46	3.39	M. Hesteltine.	5.88	4.92	5.68
M. Jackson.	6.68	5.33	4.58	I. Hyslop.	5.64	3.55	6.52
L. Dennis.	4.80	2.19	5.36	C. James.	5.90	4.23	5.71
P. McCartney.	5.82	2.94	3.96	J. Major.	6.87	2.76	6.26
F. Mercury.	5.78	4.91	5.00	K. Minogue.	5.20	2.81	5.84
R. Reagan.	6.07	3.55	4.94	V. Reeves.	5.26	3.23	6.40
C. Richard.	6.11	2.93	3.81	M. Palin.	5.91	3.16	5.60
J. Saville.	6.20	3.87	3.26	L. Pavarotti.	6.07	5.20	6.26
D. Spencer.	6.78	3.65	4.51	J. Ross.	5.71	3.07	6.07
M. Thatcher.	6.85	4.36	4.15	T. Slattery.	5.25	2.3	6.31
T. Wogan.	6.27	3.00	4.20	J. Smith.	5.53	2.21	6.59
V. Wood.	4.50	2.20	5.38	P. Swayze.	5.63	3.42	5.87
mean scores	**5.85**	**3.81**	**4.51**	**mean scores**	**5.65**	**3.35**	**6.05**
s.d.	.63	1.00	.61	s.d.	.41	.86	.36

Key: AoA = Age of acquisition, Fam = Familiarity, Dist. = Distinctiveness.

Experiment 5

Appendix 4.1.i: Participants' latency and accuracy data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	**R.T.**	**Accurate**	**R.T.**	**Accurate**
1	654	25	648	25
2	549	21	610	21
3	716	22	744	22
4	876	20	911	20
5	699	23	740	23
6	650	21	651	21
7	557	23	622	23
8	627	17	631	17
9	650	25	711	25
10	638	22	656	22
11	630	25	629	25
12	552	18	654	18
13	549	24	630	24
14	482	24	515	24
15	667	22	705	22
16	552	24	632	24
17	683	24	700	24
18	758	23	757	23
19	649	21	698	21
20	562	23	624	23
21	674	17	740	17
22	596	21	666	21
23	750	23	749	23
24	679	23	749	23
Means	**642**	**22.67**	**682**	**22.12**
s.d.	86	2.33	76	2.31

RT = Reaction times (in milliseconds), CR = The number of correct responses.

Appendix 4.1.ii: Analysis of variance for participants' familiarity latencies.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	292017.441	12696.410			
Age of Acquisition	1	19656.279	19656.279	39.599	.0000	
Error	23	11416.673	496.377			1.00

Appendix 4.1.iii: Analysis of variance for participants' accuracy data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	171.979	7.477			
Age of Acquisition	1	3.521	3.521	1.066	.3126	
Error	23	75.979	3.303			1.00

Appendix 4.1.iv: Mean *post hoc* ratings, familiarity latency and accuracy data.

Early AoA	Fam.	Dist.	AoA	R.T.	C.R.
M. Aspel.	5.28	2.38	4.85	695	24
R. Atkinson.	6.46	5.71	5.45	611	24
R. Barker.	5.74	4.75	4.06	798	22
D. Bellamy.	5.55	5.00	3.84	603	24
C. Black.	6.26	3.84	4.74	545	24
J. Cleese.	6.10	3.71	4.81	684	17
J. Collins.	6.08	4.39	4.73	658	23
P.Collins.	5.82	3.23	5.29	647	23
S. Connery.	5.45	4.13	4.62	733	20
M. Crawford.	4.54	2.39	4.47	781	14
P. Daniels.	5.71	3.38	3.91	563	23
B. Forsyth.	6.29	4.99	4.20	587	24
B. Geldoff.	5.15	4.00	5.13	767	15
Rolf Harris.	5.87	4.46	3.39	548	24
M. Jackson.	6.68	5.33	4.58	608	24
L. Dennis.	4.80	2.19	5.36	742	22
P. McCartney.	5.82	2.94	3.96	664	22
F. Mercury.	5.78	4.91	5.00	726	17
R. Reagan.	6.07	3.55	4.94	623	24
C. Richard.	6.11	2.93	3.81	585	23
J. Saville.	6.20	3.87	3.26	620	24
D. Spencer.	6.78	3.65	4.51	572	24
M. Thatcher.	6.85	4.36	4.15	530	24
T. Wogan.	6.27	3.00	4.20	629	23
V. Wood.	4.50	2.20	5.38	776	16
mean scores	**5.85**	**3.81**	**4.50**	**652**	**21.76**
s.d.	.63	1.00	.61	81	3.23

Late AoA	Fam.	Dist.	AoA	R.T.	C.R.
W. Allen.	5.17	4.72	5.55	669	20
R. Branson.	5.64	3.9	5.51	655	24
G. Bush.	6.06	2.74	5.98	657	23
B. Clinton.	5.73	2.23	6.65	790	22
J. Donovan.	5.56	2.87	5.87	686	22
B. Elton.	5.55	2.82	6.01	693	19
H. Enfield.	5.40	2.31	6.38	777	16
C. Evans.	5.56	4.20	6.76	583	24
S. Ferguson.	6.15	2.68	5.68	601	24
S. Fry.	5.97	4.41	5.94	662	24
M. Gibson.	5.37	3.46	6.03	751	22
M. Gorbachev.	5.11	3.54	5.84	721	17
A. Hopkins.	5.05	3.01	6.03	754	18
M. Hesteltine.	5.88	4.92	5.68	620	22
I. Hyslop.	5.64	3.55	6.52	661	22
C. James.	5.90	4.23	5.71	592	24
J. Major.	6.87	2.76	6.26	560	24
K. Minogue.	5.20	2.81	5.84	698	23
V. Reeves.	5.26	3.23	6.4	667	20
M. Palin.	5.91	3.16	5.6	757	19
L. Pavarotti.	6.07	5.20	6.26	678	23
J. Ross.	5.71	3.07	6.07	671	24
T. Slattery.	5.25	2.30	6.31	723	22
J. Smith.	5.53	2.21	6.59	925	9
P. Swayze.	5.63	3.42	5.87	708	24
mean scores	**5.65**	**3.35**	**6.05**	**690**	**21.24**
s.d.	.41	.86	.36	77.52	3.49

Key:
Fam = Familiarity,
Dist. = Distinctiveness
AoA = Age of acquisition,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.

Experiment 6

Appendix 4.2.i: Participants' Semantic classification latency and accuracy data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	R.T.	Accurate	R.T.	Accurate
1	750	21	861	18
2	1013	22	994	21
3	963	22	977	22
4	1986	18	1748	16
5	832	20	753	20
6	956	22	1032	23
7	787	22	883	23
8	990	23	887	19
9	649	18	692	22
10	751	22	669	23
11	1155	19	977	25
12	664	19	708	22
13	906	20	805	19
14	800	22	756	22
15	755	23	726	22
16	735	23	707	21
17	708	20	649	25
18	865	22	809	22
19	854	21	796	23
20	1189	23	865	22
21	739	23	720	21
22	1178	24	1173	21
23	1188	23	1160	24
24	668	24	647	25
Means	**920**	**21.50**	**875**	**21.71**
s.d.	285	1.77	329	2.20

Appendix 4.2.ii: Analysis of variance for participants' semantic classification latency data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	3069765.450	133468.063			
Age of Acquisition	1	24722.117	24722.117	5.060	.0344	
Error	23	112383.043	4886.219			1.00

Appendix 4.2.iii: Analysis of variance for participants semantic classification accuracy data.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	110.979	4.825			
Age of Acquisition	1	.521	.521	.166	.6871	
Error	23	71.979	3.130			1.00

Appendix 4.2.iv: Mean *post hoc* ratings, semantic classification data of items.

Early AoA	Fam.	Dist.	AoA	R.T.	C.R.
M. Aspel.	4.52	2.58	5.14	770	17
R. Atkinson.	6.54	5.50	5.46	902	17
R. Barker.	4.87	4.75	4.46	1117	19
D. Bellamy.	5.42	5.17	4.29	981	18
C. Black.	6.29	3.75	4.92	843	19
J. Cleese.	5.54	3.46	5.04	1112	18
J. Collins.	4.88	4.08	5.04	857	22
P.Collins.	5.36	2.88	5.30	854	22
S. Connery.	5.64	3.92	4.67	914	24
M. Crawford.	3.14	2.33	4.70	986	24
P. Daniels.	5.71	3.50	4.17	901	20
B. Forsyth.	6.29	5.17	4.58	873	22
B. Geldoff.	3.76	3.46	4.84	1106	23
Rolf Harris.	6.13	4.75	4.04	893	14
M. Jackson.	6.29	5.63	4.38	755	24
L. Dennis.	4.35	2.46	4.96	849	17
P. McCartney.	5.58	3.21	4.61	988	24
F. Mercury.	5.42	4.46	5.17	934	24
R. Reagan.	5.88	3.54	4.54	789	24
C. Richard.	5.75	2.79	4.17	1046	24
J. Saville.	5.83	3.92	3.88	953	18
D. Spencer.	6.67	3.88	4.25	881	24
M. Thatcher.	6.75	4.00	4.08	831	22
T. Wogan.	5.71	3.08	4.38	768	19
V. Wood.	4.81	2.25	5.16	1002	17
mean scores	**5.49**	**3.78**	**4.65**	**916**	**20.64**
s.d.	.89	.99	.44	106	3.09

Late AoA	Fam.	Dist.	AoA	R.T.	C.R.
W. Allen.	4.85	4.50	5.67	894	23
R. Branson.	5.67	4.21	5.50	956	23
G. Bush.	5.71	2.50	5.63	848	24
B. Clinton.	5.29	2.00	6.26	812	22
J. Donovan.	4.96	2.33	5.29	839	22
B. Elton.	4.86	3.04	6.17	853	18
H. Enfield.	4.09	2.33	6.00	910	15
C. Evans.	5.96	3.83	6.33	732	17
S. Ferguson.	5.88	2.58	5.38	767	24
S. Fry.	5.50	4.83	5.67	1044	11
M. Gibson.	5.17	3.25	6.04	825	24
M. Gorbachev.	4.82	3.75	5.62	836	24
A. Hopkins.	4.45	2.50	5.89	874	22
M. Hesteltine.	5.25	3.75	5.92	859	22
I. Hyslop.	5.04	3.50	6.38	855	19
C. James.	5.43	3.58	5.83	878	19
J. Major.	6.63	3.63	6.17	783	22
K. Minogue.	5.29	2.96	5.38	849	24
V. Reeves.	5.00	3.29	6.14	874	14
M. Palin.	4.70	2.79	5.68	1082	20
L. Pavarotti.	5.63	5.13	5.88	866	23
J. Ross.	5.13	2.88	5.83	718	18
T. Slattery.	4.57	2.33	6.14	997	23
J. Smith.	3.44	2.25	6.43	907	24
P. Swayze.	5.18	3.67	5.82	826	24
mean scores	**5.14**	**3.26**	**5.88**	**867**	**20.84**
s.d.	.64	.84	3.32	85	3.60

Key:
Fam = Familiarity,
Dist. = Distinctiveness
AoA = Age of acquisition,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.

Continued

Continued

Appendix 4.2.iv: Celebrities forming 'filler' items for the semantic classification tasks .

Celebrities	Occupation Classification
Joe Brown	singer
Kate Bush	singer
Par Clark	singer
Adam Faith	singer/ actor
Garry Glitter	singer
Mick Jagger	singer
Eartha Kit	singer
Shirley McClane	singer/actor
Madonna	singer/actor
George Micheal	singer/actor
Elvis Presley	singer/actor
Tim Rice	musician
Rod Stewart	singer
Judy Garland	singer/actor
Jimmy Tarbuck	commedian
Dave Allan	commedian
Clive Anderson	chat show host
Jeremy Beadle	chat show host
Dudley Moore	chat show host
Esta Rantzen	chat show host
Aneka Rice	chat show host
Philip Schofield	chat show host
Mirriam Stoppard	chat show host
Ruby Wax	chat show host
Alan Wicker	chat show host
Clive Jameson	chat show host
Marty Caine	chat show host
Nicholas Parsons	chat show host
Angus Dayton	chat show host
Micheal Barrymore	chat show host
Lesley Crowther	chat show host
Edwina Curry	chat show host
Les Dawson	chat show host
Robin Day	chat show host
David Frost	chat show host
Russel Harty	chat show host
David Jacobs	chat show host
Ian McShane	chat show host
Bob Monkhouse	chat show host
Ian Botham	chat show host
Bill Beaumont	chat show host
Jannet Brown	chat show host
Tom O'Conner	chat show host
Anne Diamond	chat show host
Johnathon King	chat show host
Russel Grant	chat show host
Muriel Gray	chat show host
Anna Ford	chat show host
Andy Crane	chat show host

Experiment 7

Appendix 5.1.i: Participants' reading speed and accuracy data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	**R.T.**	**CR**	**R.T.**	**CR**
1	523.76	25	536.33	24
2	507.75	24	540.48	25
3	519.37	19	533.91	23
4	502.00	25	572.20	25
5	509.32	25	534.24	21
6	420.33	24	445.35	23
7	609.36	25	685.29	24
8	479.79	24	422.70	23
9	535.57	23	546.19	21
10	499.26	23	525.96	25
11	826.75	24	879.92	24
12	508.71	24	547.12	25
13	448.67	24	466.75	24
14	595.67	18	560.42	19
15	854.41	22	862.39	23
16	733.48	25	838.83	24
17	496.64	25	522.09	22
18	520.30	23	626.83	24
19	450.61	23	441.83	24
20	577.96	24	568.86	22
21	493.61	18	510.32	19
22	539.39	23	555.80	25
23	467.35	20	510.48	21
24	614.08	25	569.00	23
Means	**551.42**	**23.13**	**575.14**	**23.04**
s.d.	111	2.19	124	1.78

RT = reaction time (in milliseconds), CR = number of accurate responses.

Appendix 5.1.ii: Analysis of variance for participants' reading speed from Experiment 7.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	613510.190	26674.356			
Age of Acquisition	1	6748.578	6748.578	8.256	.0086	
Error	23	18800.077	817.395			1.00

Appendix 5.1.iii: Analysis of variance for participants' reading accuracy from Experiment 7.

Source of Variation	df	Sum of Squares	Mean Square	*F*	*p*	Epsilon Correction
Participants	23	146.667	6.377			
Age of Acquisition	1	.083	.083	.052	.8218	
Error	23	36.917	1.605			1.00

Appendix 5.1.iv: Mean *post hoc* ratings, reading speed and accuracy data.

Early Age of Acquisition	Fam.	Dist.	AoA	R.T.	C.R.
M. Aspel.	5.26	2.38	4.85	560	24
R. Atkinson.	6.30	5.71	5.45	579	23
R. Barker.	5.65	4.75	3.29	581	22
D. Bellamy.	5.50	5.00	3.84	553	22
C. Black.	6.16	3.84	4.74	532	23
J. Cleese.	6.13	3.71	4.81	548	22
J. Collins.	6.00	4.39	4.73	575	24
P.Collins.	5.79	3.23	5.29	508	21
S. Connery.	5.40	4.13	4.62	574	19
M. Crawford.	4.44	2.39	4.47	623	19
P. Daniels.	5.67	3.38	3.91	538	21
B. Forsyth.	6.19	4.99	4.20	545	22
B. Geldoff.	5.11	4.00	5.13	560	20
Rolf Harris.	5.64	4.46	3.39	553	24
M. Jackson.	6.40	5.33	4.58	505	23
L. Dennis.	5.58	2.19	5.36	477	23
P. McCartney.	5.62	2.94	3.96	546	21
F. Mercury.	5.80	4.91	5.00	559	23
R. Reagan.	6.04	3.55	4.94	592	24
C. Richard.	6.00	2.93	3.81	496	22
J. Saville.	6.10	3.87	3.26	571	24
D. Spencer.	6.54	3.65	4.51	634	21
M. Thatcher.	6.45	4.36	4.15	586	24
T. Wogan.	6.07	3.00	4.20	507	21
V. Wood.	4.45	2.20	5.38	506	23
mean scores	**5.77**	**3.81**	**4.48**	**552.30**	**22.20**
s.d.	0.54	1.00	0.66	38.00	1.53

Late Age of Acquisition	Fam.	Dist.	AoA	R.T.	C.R.
W. Allen.	5.22	4.72	5.69	517	23
R. Branson.	5.80	3.90	5.67	582	22
G. Bush.	6.15	2.74	5.88	551	23
B. Clinton.	5.70	2.23	6.59	558	22
J. Donovan.	5.60	2.87	5.94	555	20
B. Elton.	5.60	2.82	6.22	536	23
H. Enfield.	6.05	2.31	6.47	571	23
C. Evans.	5.45	4.20	6.69	534	23
S. Ferguson.	6.20	2.68	5.88	614	24
S. Fry.	6.19	4.41	5.64	587	23
M. Gibson.	5.43	3.46	6.13	535	24
M. Gorbachev.	5.17	3.54	5.74	692	15
A. Hopkins.	5.10	3.01	6.16	540	21
M. Hesteltine.	5.90	4.92	5.84	592	22
I. Hyslop.	5.60	3.55	6.65	682	23
C. James.	5.95	4.23	5.81	514	23
J. Major.	6.00	2.76	6.04	523	23
K. Minogue.	5.20	2.81	5.95	611	24
V. Reeves.	5.30	3.23	6.33	513	22
M. Palin.	5.94	3.16	5.36	546	23
L. Pavarotti.	6.10	5.20	6.15	942	19
J. Ross.	5.70	3.07	6.10	568	22
T. Slattery.	5.24	2.30	6.26	581	22
J. Smith.	5.70	2.21	6.52	507	22
P. Swayze.	5.75	3.42	5.79	552	22
mean scores	**5.71**	**3.35**	**6.06**	**580.21**	**22.12**
s.d.	0.40	0.86	0.35	89.00	1.88

Key:
Fam = Familiarity,
Dist. = Distinctiveness
AoA = Age of acquisition,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.

Experiment 8

Appendix 5.2.i: Participants' familiarity decision speed and accuracy data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	R.T.	CR	R.T.	CR
1	785.63	24	815.84	25
2	582.17	23	642.48	23
3	598.60	25	588.09	23
4	678.23	22	700.55	20
5	613.68	25	672.44	25
6	520.68	25	556.35	23
7	561.57	23	569.21	24
8	561.45	22	609.50	20
9	577.17	24	729.00	21
10	564.25	24	585.38	21
11	815.21	24	760.52	25
12	582.60	25	623.76	25
13	631.08	24	609.09	23
14	551.71	24	518.52	21
15	522.28	25	569.17	24
16	486.57	23	557.13	24
17	678.08	24	617.17	23
18	654.27	22	681.43	21
19	750.54	24	754.24	21
20	786.61	18	844.11	18
21	483.67	24	545.81	21
22	670.39	23	773.36	25
23	644.63	24	710.43	23
24	806.40	25	857.75	24
Means	**629.48**	**23.58**	**662.14**	**22.63**
s.d.	100	1.53	99.74	1.95

RT = Reaction times (in milliseconds) CR = The number of correct responses.

Appendix 5.2.ii: Analysis of variance for participants' familiarity decisions.

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	432104.514	18787.153			
Age of Acquisition	1	12800.760	12800.760	11.153	.0028	
Error	23	26397.053	1147.698			1.00

Appendix 5.2.iii: Analysis of variance for participants' familiarity accuracy data

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	114.979	4.999			
Age of Acquisition	1	11.021	11.021	9.573	.0051	
Error	23	26.479	1.151			1.00

Appendix 5.2.iv: Mean *post hoc* ratings, familiarity decision speed and accuracy data.

Early Age of Acquisition	Fam.	Dist.	AoA	R.T.	C.R.
M. Aspel.	5.28	2.38	4.85	643.55	22
R. Atkinson.	6.46	5.71	5.45	649.83	23
R. Barker.	5.74	4.75	4.06	864.94	16
D. Bellamy.	5.55	5.00	3.84	657.30	23
C. Black.	6.26	3.84	4.74	528.88	24
J. Cleese.	6.10	3.71	4.81	582.86	22
J. Collins.	6.08	4.39	4.73	557.75	24
P.Collins.	5.82	3.23	5.29	572.42	24
S. Connery.	5.45	4.13	4.62	594.00	23
M. Crawford.	4.54	2.39	4.47	714.55	22
P. Daniels.	5.71	3.38	3.91	598.13	23
B. Forsyth.	6.29	4.99	4.20	597.04	23
B. Geldoff.	5.15	4.00	5.13	612.13	24
Rolf Harris.	5.87	4.46	3.39	598.79	24
M. Jackson.	6.68	5.33	4.58	626.21	24
L. Dennis.	4.80	2.19	5.36	557.05	21
P. McCartney.	5.82	2.94	3.96	658.88	24
F. Mercury.	5.78	4.91	5.00	690.91	22
R. Reagan.	6.07	3.55	4.94	627.04	23
C. Richard.	6.11	2.93	3.81	580.63	24
J. Saville.	6.20	3.87	3.26	614.46	24
D. Spencer.	6.78	3.65	4.51	943.41	17
M. Thatcher.	6.85	4.36	4.15	617.13	24
T. Wogan.	6.27	3.00	4.20	576.92	24
V. Wood.	4.50	2.2	5.38	601.91	22
mean scores	**5.85**	**3.81**	**4.51**	**634.67**	**22.64**
s.d.	0.63	1.00	0.61	92.00	2.60

Late Age of Acquisition	Fam.	Dist.	AoA	R.T.	C.R.
W. Allen.	5.17	4.72	5.55	636.83	24
R. Branson.	5.64	3.90	5.51	717.92	24
G. Bush.	6.06	2.74	5.98	633.75	24
B. Clinton.	5.73	2.23	6.65	647.73	22
J. Donovan.	5.56	2.87	5.87	683.04	23
B. Elton.	5.55	2.82	6.01	568.88	24
H. Enfield.	5.4	2.31	6.38	659.83	23
C. Evans.	5.56	4.2	6.76	607.67	24
S. Ferguson.	6.15	2.68	5.68	782.00	18
S. Fry.	5.97	4.41	5.94	627.45	22
M. Gibson.	5.37	3.46	6.03	543.25	24
M. Gorbachev.	5.11	3.54	5.84	977.47	19
A. Hopkins.	5.05	3.01	6.03	617.33	24
M. Hesteltine.	5.88	4.92	5.68	639.00	23
I. Hyslop.	5.64	3.55	6.52	850.00	14
C. James.	5.9	4.23	5.71	609.77	22
J. Major.	6.87	2.76	6.26	577.33	24
K. Minogue.	5.2	2.81	5.84	589.27	22
V. Reeves.	5.26	3.23	6.4	609.52	21
M. Palin.	5.91	3.16	5.6	699.81	21
L. Pavarotti.	6.07	5.20	6.26	762.50	22
J. Ross.	5.71	3.07	6.07	606.33	24
T. Slattery.	5.25	2.3	6.31	664.68	22
J. Smith.	5.53	2.21	6.59	812.20	10
P. Swayze.	5.63	3.42	5.87	685.35	23
mean scores	**5.65**	**3.35**	**6.05**	**672.36**	**21.72**
s.d.	0.41	0.86	0.36	99.00	3.4

Key:

Fam = Familiarity,
Dist. = Distinctiveness
AoA = Age of acquisition,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.

EXPERIMENT 9:

Appendix 5.4.i: Participants' mean semantic classification data.

	Early Age of Acquisition		Late Age of Acquisition	
Participants	**R.T.**	**CR**	**R.T.**	**CR**
1	798.00	24	778.38	24
2	1246.15	13	1297.31	13
3	351.33	15	339.56	16
4	759.14	21	926.50	20
5	1013.75	20	1104.81	21
6	750.52	21	744.70	23
7	608.22	18	601.48	21
8	413.60	10	320.78	9
9	575.00	16	618.71	17
10	1053.94	16	1011.78	18
11	721.81	21	644.13	16
12	835.52	21	769.63	19
13	744.00	15	692.68	19
14	902.10	21	897.52	23
15	1052.45	20	1011.59	22
16	991.96	24	959.95	20
17	852.39	23	931.22	23
18	1145.32	19	1462.83	18
19	913.19	21	1007.45	22
20	725.45	20	769.52	25
21	1097.30	23	1135.48	21
22	1013.75	24	988.87	23
23	887.85	20	788.35	20
24	979.48	23	861.14	22
Means	**851.34**	**19.54**	**861.02**	**19.79**
s.d.	221.06	3.68	263.62	3.68

RT = reaction times (in milliseconds), CR = the number of accurate responses.

Appendix 5.3.ii: Analysis of variance for participants' semantic classification to names.

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	2617816.423	113818.105			
Age of Acquisition	1	1122.784	1122.784	.247	.6239	
Error	23	104569.609	4546.505			1.00

Appendix 5.3.iii: Analysis of variance for participants' name classification accuracy

Source of Variation	df	Sum of Squares	Mean Square	F	p	Epsilon Correction
Participants	23	562.667	24.464			
Age of Acquisition	1	.750	.750	.282	.6007	
Error	23	61.250	2.663			1.00

Appendix 5.3.iv: Mean *post hoc* ratings, semantic classification speed and accuracy data.

Early Age of Acquisition	Fam.	NmL	AoA	R.T.	C.R.
M. Aspel.	4.54	12	3.82	813.65	20
R. Atkinson.	5.88	13	5.00	985.29	17
R. Barker.	5.64	11	3.96	1071.06	16
D. Bellamy.	5.90	12	5.00	999.00	13
C. Black.	5.17	10	4.94	952.12	17
J. Cleese.	5.97	10	3.81	973.12	17
J. Collins.	5.37	11	3.26	819.42	19
P.Collins.	5.11	11	4.51	773.25	20
S. Connery.	5.05	11	4.15	728.16	19
M. Crawford.	5.88	15	4.20	950.05	21
P. Daniels.	5.64	12	5.38	838.63	19
B. Forsyth.	5.90	12	4.85	797.30	20
B. Geldoff.	6.87	10	4.55	795.52	21
Rolf Harris.	5.20	10	4.06	895.40	15
M. Jackson.	5.26	14	3.84	819.83	24
L. Dennis.	5.91	9	4.74	809.56	18
P. McCartney.	6.07	14	4.81	866.19	21
F. Mercury.	5.71	13	4.73	915.10	21
R. Reagan.	6.15	12	5.29	836.75	20
C. Richard.	5.97	12	4.62	695.86	22
J. Saville.	5.37	12	4.47	1081.63	16
D. Spencer.	5.11	13	3.91	913.36	22
M. Thatcher.	6.07	15	4.20	842.00	21
T. Wogan.	6.11	10	5.13	750.32	22
V. Wood.	6.20	12	3.39	1039.38	8
mean scores	**5.68**	**11.84**	**4.43**	**878.48**	**18.76**
s.d.	0.50	1.60	0.58	106.00	3.41

Late Age of Acquisition	Fam.	NmL	AoA	R.T.	C.R.
W. Allen.	6.02	10	6.40	865.33	18
R. Branson.	6.01	14	6.25	1004.43	21
G. Bush.	5.82	10	5.68	885.36	22
B. Clinton.	5.78	11	5.94	806.19	21
J. Donovan.	6.07	12	6.03	773.48	23
B. Elton.	6.11	8	5.84	746.93	14
H. Enfield.	6.20	12	6.03	1029.08	12
C. Evans.	6.78	10	5.68	727.52	21
S. Ferguson.	6.85	13	6.52	944.68	22
S. Fry.	6.27	10	5.71	812.33	9
M. Gibson.	4.50	10	6.26	821.35	23
M. Gorbachev.	5.25	18	5.84	1001.94	18
A. Hopkins.	5.60	14	6.40	981.57	23
M. Hesteltine.	5.28	17	5.60	980.47	19
I. Hyslop.	6.46	9	6.26	1101.71	14
C. James.	5.74	10	5.84	773.83	23
J. Major.	5.55	9	6.40	822.95	21
K. Minogue.	6.26	12	5.60	739.55	20
V. Reeves	6.10	9	6.26	820.50	18
M. Palin.	6.08	11	6.07	997.85	13
L. Pavarotti.	5.82	19	6.31	936.35	23
J. Ross.	5.45	13	6.59	768.45	20
T. Slattery.	4.54	12	5.87	766.57	14
J. Smith.	5.71	9	5.36	1057.65	20
P. Swayze.	4.95	13	5.00	770.57	23
mean scores	**5.81**	**11.80**	**6.01**	**877.47**	**19.00**
s.d.	0.59	1.60	0.35	115.00	4.06

Key:
AoA = Age of acquisition,
Fam = Familiarity,
NmL = Leter length in the full name,
RT = Reaction times (in milliseconds),
CR = The number of accurate responses.