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What's in a name? access to information from people's names

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What's in a Name? Access to Information from People's Names

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The processing of people's names is contrasted with face recognition and word recognition. The effects of the familiarity of initial and surnames and frequency of surnames (the number of people with the same surname) were investigated in several tasks. It was found that the effects of name familiarity and surname frequency were analogous to the effects of word frequency in tasks which did not require access to memory for individuals (a nationality decision and naming latency). In tasks which do require access to memory for individuals (familiarity decision and a semantic classification), the effect of surname frequency was analogous to the effect of distinctiveness in face recognition. The results are discussed in terms of a functional model of name processing in which name recognition units mediate between the output of word recognition units and access to identity-specific semantics.

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INTRODUCTION

Much of the recent theoretical development in the face recognition literature has resulted from an analogy drawn between recognition of familiar faces and words (Bruce, 1979; 1981, 1983). The most influential theoretical development that has resulted from this analogy has been the emergence of information-processing models of face recognition, based on the concept of face recognition units (Bruce & Young, 1986; Ellis, 1986; Hay & Young, 1982). The original conception of a face recognition unit (FRU) was as a threshold device (Hay & Young, 1982), directly analogous to a logogen in Morton's (1969; 1979) model of word recognition. Each face recognition unit is assumed to contain a stored structural description of a familiar face. Thus there is an FRU for every known face, which will be activated by all occurrences of a particular individual's face. In later models, FRUs are seen as signalling resemblance rather than as operating in a binary fashion (see Bruce & Young, 1986). The level of the output of an FRU will depend upon the resemblance between the stored representation of a familiar face and the current input from earlier visual processing. The FRUs mediate between structural encoding processes and the access of semantic information about individuals (identity-specific semantic information; see Fig. 1). An activated FRU enables the semantic information about the appropriate individual to be accessed.

Bruce and Young (1986) note that there is a sequence of functional components which is common to the recognition and naming of objects, faces and words. Briefly, the sequence comprises formation of an input code; activation of a recognition unit; access to semantic information; and, finally, access to a name code. Word recognition differs in that it is assumed that name codes can be activated directly from the word recognition units (see Fig. 1). This framework has been successful in accounting for similarities and differences between face, word and object recognition in a range of experimental paradigms including priming (Bruce, 1986a; Bruce & Valentine, 1985; 1986; Ellis, Young, Flude & Hay, 1987), semantic categorisation and naming (Young, McWeeny, Ellis & Hay, 1986b; Young, McWeeny, Hay & Ellis, 1986c) and interference studies (Bredart, 1989; Young et al., 1986a: See Bruce & Young, 1986 and Young & Ellis, 1989, for reviews).

Most of the experiments cited above, which were inspired by comparisons between faces and words, have in fact involved comparisons between faces and people's names. Thus the analogy implies that names are arbitrary verbal labels associated with faces and are represented and processed in the same way as words. This begs the question of whether a distinction between words and names should be made in the analogy with face recognition.

Frequency of occurrence of stimuli is one factor that has received comparatively little attention in the analogy between faces and words, despite the ubiquitous effects of word frequency in the word recognition literature. There are at least two reasons why this factor may have been overlooked. First, there is some theoretical debate in the word recognition literature about the locus of word frequency effects (see Monsell, Doyle & Haggard, 1989, for a brief review). Traditional models of word recognition have attributed word frequency effects to the identification process being frequency sensitive. For example, in a recognition unit model, the recognition units for high-frequency words could either have a lower threshold or a higher resting level of activation than the recognition units for low-frequency words. Recently, it has been argued that the identification of visually presented words is not frequency sensitive but the major effects of frequency arise from later task-specific processes (Balota & Chumbley, 1984; 1985). However, Monsell et al. (1989) present evidence that unique identification rather than later processes is the primary locus of frequency effects.

A second problem in using the analogy between words and faces to explore the effects of frequency is that the appropriate analogy is not clear. A possible analogy exists between the degree of familiarity of a face and the frequency of a word. Initially, this analogy appears promising. Familiarity has been found to facilitate RT in a familiarity decision task (Valentine & Bruce, 1986a). Bruce (1983) argues that a familiarity decision (i.e. deciding whether a face is familiar) is analogous to a lexical decision between words and pronounceable nonwords (i.e. deciding whether a letter string is familiar). Therefore, the effect of familiarity of a face in a familiarity decision task is analogous to the advantage found for high-frequency words in a lexical decision task. However, there is a sense in which the familiarity of a face differs from the frequency of a word. A high-frequency word is usually used to refer to any occurrence of a concept (e.g. the word "dog" will be used to refer to a particular dog or to any dog). In contrast, the familiarity of a face is always associated with the same individual. A full name or initial and surname may be familiar because it is the name of a familiar individual, in the same way that an individual's face can be familiar. This will be referred to as the *familiarity* of a name. However, it is important to note that the familiarity of an individual's face and the familiarity of an individual's name are not equivalent. For example, a film actor's face may be more familiar than his name. (It is possible to recognise that an actor has appeared in a previous film without knowing his name.) It is also possible for a name to be more familiar than a face. For example, a newspaper columnist's name might be familiar but her face entirely unfamiliar.

A name (either a first name or surname alone) may also be familiar because it is shared by many people. For example, the surname "Moore" might refer to Roger Moore (actor), Patrick Moore (astronomer), Dudley Moore (actor) or many other individuals who share the same surname. A measure of the number of people who have the same name will be referred to as the *frequency* of a name. Thus, familiarity of names and faces is a property related to the individual person. The number of times a name is encountered will depend on the frequency of the name and the degree of familiarity of people who have the name. Word frequency is an estimate of the relative number of times a word will be encountered, and therefore is analogous to the combined effects of the familiarity and frequency of a name. It should be noted that the familiarity of a name can only be assessed for a name unique to an individual (e.g. an initial and surname or full name), but frequency can refer to either a first or surname alone.

Names are a sub-class of words and must obviously share some early processing in common with word recognition. However, names have some properties in common with words and some properties in common with faces. Like words, names can access all occurrences of the name or word. For example, the word "Moore" can apply to all individuals who have the surname Moore. Like faces, names can also access semantic information specific to individuals. For example, reading the name Roger Moore accesses information about the actor who is best known for playing James Bond in films.

We propose that name recognition units, the logical equivalent of face recognition units, mediate between the word recognition system and access to identity-specific semantic information about individuals (see Fig. 1). The output of word recognition units which represent names connect to name recognition units. The input to name recognition units could be first or surnames alone, initial and surname or full names. There is a word recognition unit for every familiar word (or name) and there is a name recognition unit for every familiar individual. Phonological output codes can be accessed directly from name recognition units. This route is analogous to the direct route from word recognition units to phonological output codes. Young et al. (1986b) and Young, Ellis and Flude (1988) report evidence that phonological output codes (name codes) can be accessed in parallel to identity-specific semantics from written names but that phonological output codes can only be accessed from faces via identity-specific semantics.

The experiments reported here are intended as an exploratory study of the effects of familiarity and frequency in processing names. Research concerning the processes involved in recognising names has been rather neglected compared to the amount of research on recognising faces, though there has been quite a lot of recent research on name *recall*. McWeeny, Young, Hay & Ellis (1987) showed that names are particularly

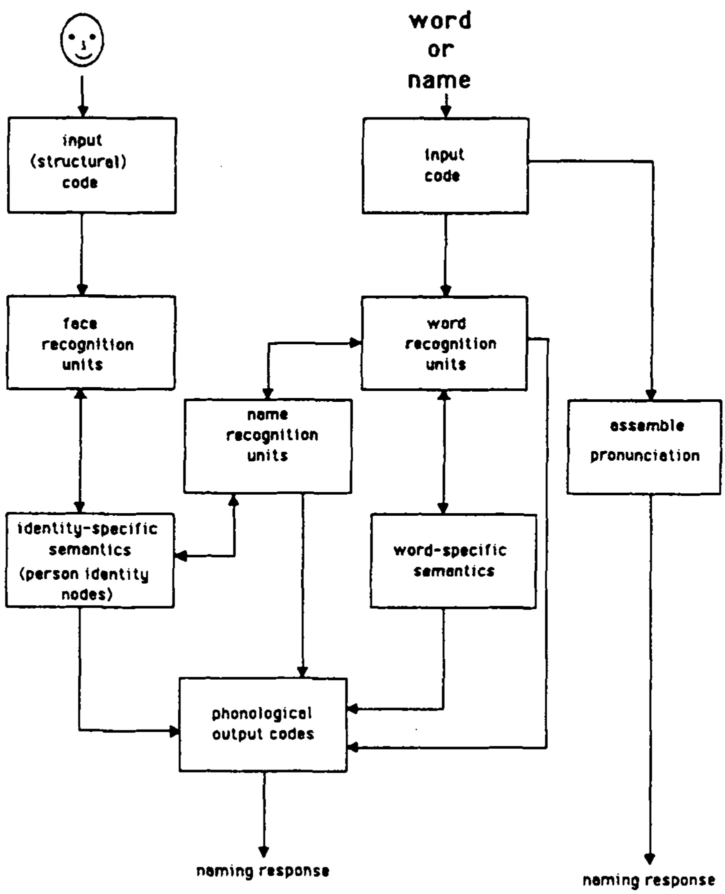

FIG. 1. A functional model of face, name and word recognition. The routes for face and word recognition are standard models adapted from Bruce and Young (1986), except that a route for naming unfamiliar words is shown. It is proposed that name recognition proceeds via name recognition units which mediate between word recognition units and identity-specific semantics.

difficult to recall in a laboratory task. Indeed, naming famous faces has been found to be an effective way of eliciting a tip-of-the-tongue state in the laboratory (Hanley & Cowell, 1988; Yarmey, 1973). Difficulty in remembering names is often reported in everyday life (Young, Hay & Ellis, 1985), particularly among the elderly (Cohen & Faulkner, 1986; Martin, 1986). Flude, Ellis & Kay (1989) described an anomic aphasic patient who could not name many familiar faces but had full access to semantic information about familiar people. Semenza and Zettin (1988; 1989) report cases of a selective anomia for proper names. Therefore, a systematic study of the processes involved in recognising and recalling names is of some practical as well as theoretical significance.

Experiments 1 and 2 are intended to examine the effects of frequency and familiarity in tasks which do not require access to information relating to specific individuals. Experiment 1 involves a decision concerning the probable national origin of names (Belgian *vs* British). It is assumed that the task only demands analysis at the level of an input code but can be facilitated by the activation of a word recognition unit (see below). In Experiment 2, the effect of familiarty and frequency on pronunciation latency for names is examined. This task is assumed to require access to phonological output codes. In Experiments 3 and 4, a familiarity decision to names is required. This decision can be based on the output of name recognition units. Experiment 5 explores frequency effects in a semantic classification task and is assumed to require access to identity-specific semantics.

EXPERIMENT 1

In Experiment 1, the subjects were required to judge whether a name was British or Belgian. It was assumed that this decision could be based on the input code. It is possible to judge the likely nationality of a name even if it has never been encountered before (i.e. there is no appropriate word recognition unit). This task is designed to be an approximate analogue of face processing tasks which can be based on an input from the structural code (e.g. the derivation of visually derived semantics: Bruce & Young, 1986), including tasks such as sex judgements or a task in which intact and jumbled faces must be distinguished (Bruce, 1986b; Valentine & Bruce, 1986b). Such judgements can be made on the basis of the input (structural) code for faces, but Bruce (1986b) found that both sex judgements and face classification can be made more rapidly to familiar faces than to unfamiliar faces, presumbly due to a top-down influence from FRUs for familiar faces. An appropriate analogue from word recognition to the nationality decision task used in Experiment 1, might be one which requires subjects to classify letter strings as similar to words of their own language or a foreign language. However, we know of no studies in which the effect of word frequency has been examined in such a task.

A nationality judgement could be based upon the degree to which the input code resembles an English orthography. However, if there is a word recognition unit for the name, the activation of a word recognition unit could also provide an input to the nationality decision process (cf. Bruce, 1986b; see Fig. 1). A "British" response made on the basis of activation of a word recognition unit would be almost certainly correct, as all Belgian names in Experiment 1 were unfamiliar to the subjects. Word recognition units would only exist for names which had been encountered before. Therefore, low-frequency, unfamiliar names are the only class of British names for which word recognition units are unlikely to exist. If it is assumed that the nationality decision process accumulates evidence from the input code and top-down influence from the word recognition units until some criterion is reached, the classification of low-frequency, unfamiliar British names would be slower than the other names because the input from word recognition units would be unavailable.

An effect of frequency on classification of familiar British names was not predicted because the nationality decision task does not require unique identification at the word recognition unit level. The input to this decision could be based on a measure of overall activity among word recognition units without the need to identify one particular unit as activated. Monsell et al. (1989) point out that there is no reason to suppose that such use of the lexicon should be frequency sensitive.

Method

Subjects. A total of 24 students from the University of Cambridge acted as subjects, of whom 21 were males and 3 females.

Stimuli. Eighty names served as the stimuli for Experiment 1: 40 were British names and 40 were Belgian names. Each name consisted of an initial and surname. The names were selected according to the frequency of occurrence of the surname and the rated familiarity of the initial and surname using the criteria stated below. The 40 names of each nationality consisted of: 10 familiar, high-frequency names; 10 familiar, low-frequency names; 10 unfamiliar, high-frequency names; and 10 unfamiliar, low-frequency names. The British names were selected on the following criteria. The frequency of a surname was estimated by counting the number of occurrences in the Cambridge and district telephone directory. The high-frequency surnames had a minimum of 1 occurrence per 5000 entries. The low-frequency surnames had a maximum of 1 occurrence per 50,000 entries and had at least 1 entry in the directory. A set of "familiar" and "unfamiliar" names was generated by pairing surnames of famous people with the appropriate initial, and names for which the experimenters could not think of a famous person with an initial from the set used for famous names chosen at random. Twenty students, who did not take part in any of the subsequent experiments, rated each name (initial and surname) for familiarity on a 7-point scale (1 = unfamiliar, 7 = highly familiar). These ratings were used to select the set of British names used in Experiments 1–3. Each of the four sets of ten items were matched on the length of the surname. As far as possible, surnames with unusual spelling

TABLE 1
Mean Familiarity Ratings, Frequency (Occurrences per 100,000 Entries) and Number of Letters in Surname of the British Names Used in Experiments 1–3 (standard deviations are shown in parentheses)

	Familiar Names		*Unfamiliar Names*	
	High-frequency	*Low-frequency*	*High-frequency*	*Low-frequency*
Familiarity	6.23 (0.35)	6.27 (0.49)	1.51 (0.35)	1.32 (0.21)
Frequency	128.10 (108.0)	1.23 (0.54)	128.03 (124.6)	1.43 (0.50)
Number of letters	6.2 (1.62)	5.6 (1.26)	5.7 (1.06)	5.9 (0.87)

patterns, or surnames which are also English words, were avoided. The mean familiarity, frequency and word length of each of the four classes of names are shown in Table 1. The stimuli are listed in the Appendix.

The set of 40 Belgian names used in this experiment were selected in a similar manner from the Liege and district telephone directory. Familiarity ratings were obtained from Belgian students. Belgian names that also occurred in the Cambridge telephone directory were excluded, with the exception of one name which had one occurrence only. These stimuli were also used in Experiments 4 and 5. Full details of the selection criteria are given in the description of the method of Experiment 4 and the stimuli are listed in the Appendix. Although the Belgian names were divided into the same four categories used for the British names, this categorisation was based on the ratings of Belgian students. All of the Belgian names were unfamiliar to the British subjects in this experiment.

Apparatus. A BBC microcomputer was used to present the stimuli and log responses and reaction times from two response buttons.

Design. The design included three within-subjects factors: the nationality, familiarity and frequency of the names. Ten stimuli in each cell of the design were presented. The task was to classify the names according to their nationality as quickly as possible. The Belgian names were included to generate the task demand. The results of primary interest were the effects of familiarity and frequency upon classification of the British names. The dependent variable was reaction time.

Procedure. The experiment was preceded by a block of 20 practice trials. The items used in these trials were not used in the experimental trials, 10 were British names, 10 were Belgian names. Each name was presented in upper case in the centre of the screen until a response was made. The inter-stimulus interval was 2 sec. Four different random orders were used, and six subjects were tested with each order. The stimuli were presented in blocks of 20 items. The first block consisted of the practice items followed by four experimental blocks. The response buttons were labelled "British" and "Belgian". The subjects were told that they would see a series of names, half of which were British surnames and half of which were Belgian surnames. They were asked to judge whether each name was likely to be of British or Belgian origin as quickly but as accurately as possible. The subject held one response button in each hand. The assignment of buttons to the preferred or non-preferred hand was counterbalanced across subjects. Reaction times less than 200 msec or over 2 sec were treated as missing data.

Results

Separate analyses of British and Belgian names were carried out. The analysis of responses to British names will be discussed first. The mean error rate for British names was 14.4% (the analysis of errors is discussed below). The mean reaction times of correct responses to British names are plotted in Fig. 2. These data were subjected to an ANOVA with familiarity and frequency as within-subjects factors. There was a main effect of familiarity [$F(1,23) = 16.10$, $P < 0.001$]. Names of famous people were classified as British more quickly than unfamiliar names. There was a main effect of frequency [$F(1,23) = 28.82$, $P < 0.001$]. High-frequency names were classified more quickly than low-frequency names. There was also a significant interaction between these factors [$F(1,23) = 17.09$, $P < 0.001$]. Tukey HSD tests were used to analyse significant interactions in all of the experiments reported. Where critical differences (HSD) are quoted, unless stated otherwise, a statistical significance level of 0.05 was used. The main effect of familiarity was significant for low-frequency names ($P < 0.01$), but was not significant for high-frequency names (HSD = 51.5 msec). The main effect of frequency was significant for unfamiliar names ($P < 0.01$), but was not significant for familiar names (HSD = 55.2 msec). An items analysis of the RT data was also carried out, with frequency and familiarity as between-items factors. The results supported those obtained in the subjects analysis. There was a significant main effect of familiarity [$F(1,36) = 11.22$, $P < 0.005$] and frequency [$F(1,36) = 12.93$, $P < 0.001$]. The interaction was also significant [$F(1,36) = 5.94$, $P < 0.05$]. Tukey HSD tests showed that the effect of frequency was significant for unfamiliar names ($P < 0.01$), but was not significant for familiar names. The effect of familiarity was significant for low-frequency names ($P < 0.01$), but was not

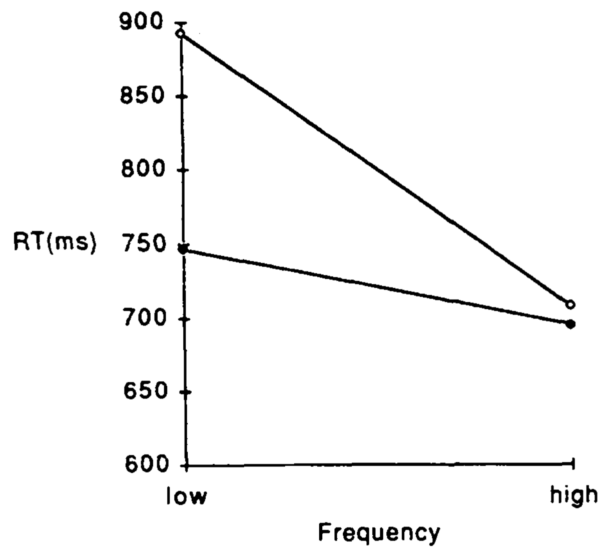

FIG. 2. Mean reaction time to correctly classify names as "British" as a function of familiarity and frequency (Experiment 1). ●, Familiar; ○, unfamiliar.

significant for high-frequency names (HSD = 57.9 msec for all comparisons).

In view of the error rate being reasonably high (mean 14.4%), an ANOVA of errors made to British names was also carried out. The mean number of errors in each condition are plotted in Fig. 3. The main effect of familiarity was significant [$F(1,23) = 66.05$, $P < 0.001$]. More errors were made to unfamiliar names than to familiar names. The main effect of frequency was significant [$F(1,23) = 24.31$, $P < 0.001$]. More errors were made to low-frequency names than to high-frequency names. There was also a significant interaction between familiarity and frequency [$F(1,23 = 6.18$, $P < 0.05$]. Tukey HSD tests of the simple main effects showed that the interaction was due to a significant effect of frequency for unfamiliar names ($P < 0.01$), which was not found for familar names (HSD = 0.449). The simple main effect of familiarity was significant for both high-frequency names ($P < 0.01$) and for low-frequency names ($P < 0.01$; HSD = 0.535). The errors made to British names were also analysed by item. An ANOVA with familiarity and frequency as between-items factors revealed a main effect of familiarity [$F(1,36) = 12.98$, $P < 0.001$] and frequency [$F(1,36) = 4.11$, $P = 0.05$]. The interaction between familiarity and frequency was not significant in this analysis [$F(1,36) = 2.48$, $0.10 < P < 0.15$].

The Belgian names were included to generate the necessary task de-

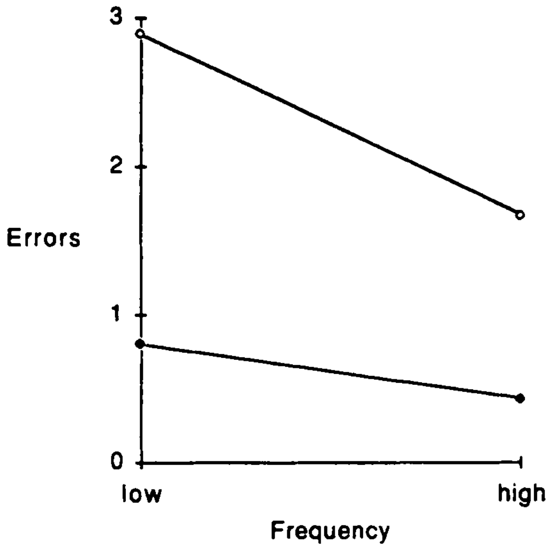

FIG. 3. Mean number of errors (chance = 5) in classifying names as "British" as a function of familiarity and frequency (Experiment 1). ●, Familiar; ○, unfamiliar.

mand, and were all unfamiliar and of low frequency to the subjects who took part in this experiment. Therefore, it was expected that no effects of frequency and familiarity would be found. The mean error rate for Belgian names was 14.8%. An analysis of the error data is reported below. An ANOVA of RT data revealed a significant main effect of frequency [$F(1,23) = 12.00$, $P < 0.005$]. High-frequency names were correctly classified as Belgian more quickly than low-frequency names. The interaction term was also significant [$F(1,23) = 4.47$, $P < 0.05$]. Tukey HSD tests showed that the effect of frequency was significant for "unfamiliar" Belgian names ($P < 0.01$), but not for "familiar" Belgian names. There were no significant effects in an items analysis of the RT data.

An ANOVA of errors made to Belgian names revealed only a main effect of familiarity [$F(1,46) = 6.41$, $P < 0.05$]. Less errors were made to "familiar" names than to "unfamiliar" names.

Discussion

The results of trials in which British names were presented, have clearly shown that both the familiarity of a name and its frequency in the population can affect the RT taken to classify a name as British. The effects have been found to be interactive rather than additive. The analyses by subjects and by items both show that frequency only affects the RT to accept unfamiliar names and that the effect of familiarity is only found for low-frequency names. Reaction time to unfamiliar, low-frequency names is slower than reaction times to the other three classes of names, which do not differ from each other. This pattern of results is broadly consistent with the input code and activation of the word recognition units providing input to the nationality decision process. Decisions to low-frequency, unfamiliar names are slower because there is no input from the word recognition units for these names. There was no effect of frequency on decisions to familiar names. This is consistent with the assumption that the primary source of frequency effects is at the level of unique identification among the word recognition units which was not required by the nationality decision task.

An analysis of the error data also revealed that the effects of familiarity and frequency were interactive. As in the RT data, frequency only affected the accuracy of classifying unfamiliar names. However, in the error data, there was an advantage for familiar names over unfamiliar names independent of frequency. If this was due to the combined effect of familiarity and frequency of high-frequency, familiar names being greater than that of high-frequency, unfamiliar names, it is not clear why an effect of familiarity on RT to high-frequency names was not found. An alternative *post-hoc* explanation would be top-down influence from activity in the name recognition units providing an input to the nationality decision process. As there will only be name recognition units for familiar individuals, an input from name recognition units would contribute to an effect of familiarity for high- and low-frequency names. If recognition of a high-frequency name as a familiar individual is slow compared to nationality decision (see Experiment 3), the name recognition units could only influence the accuracy of slow nationality decisions. Therefore, the effect of activity in name recognition units would be expected to affect accuracy but not RT of nationality decisions to high-frequency names. This suggestion is supported by an informal between-subjects comparison between the mean RT for nationality decision to high-frequency familiar names in Experiment 1 (694 msec) and RT for familiarity decisions to the same names in Experiment 3 (789 msec). The equivalent comparison for low-frequency names is 746 and 748 msec respectively.

No effects had been predicted for the classification of Belgian names. However, it was found that high-frequency Belgian names were classified faster than low-frequency Belgian names. An examination of the stimuli suggested that the subjects may have been using spelling patterns in some names which were more common in French than in English (e.g. names ending in -et, -ez). The fact that the effect was not reliable across items suggests that there were a few items contributing to the effect. As no effect had been predicted, the sets of items were not well suited to examining it. However, the effect is consistent with the assumption that the nationality decision could be based on the input code. Spelling patterns which are unusual in British names could be rapidly rejected as British. An experiment designed to examine this point may be able to demonstrate that the subjects were sensitive to the orthography of names.

EXPERIMENT 2

The aim of Experiment 2 was to explore further the comparison between words and names by examining the effect of familiarity and frequency of names in a naming task. The task required the surname only of an initial and surname to be read aloud. In a naming task it is assumed that phonological output codes can be accessed directly from word recognition units for names as for words (see Fig. 1). There is some debate in the word recognition literature about the magnitude of the effect of frequency on naming latency. However, there is good evidence that high-frequency words can be pronounced faster than low-frequency words, although the effect is larger for irregular than regular words (Monsell et al., 1989; Seidenberg, Waters, Barnes & Tannenhaus, 1984). It should be noted that as far as possible irregular names were avoided in the stimulus set used in Experiment 2. The word recognition literature suggests that this would reduce the magnitude of the frequency effect to be expected. Notwithstanding the use of regular names, it was predicted that high-frequency names would be pronounced faster than low-frequency names. It was also predicted that low-frequency, unfamiliar names would be pronounced more slowly than either familiar names or high-frequency, unfamiliar names because a recognition unit is less likely to exist for low-frequency, unfamiliar names. If no recognition unit exists for a name because it has not been seen previously, the name must be read using grapheme–phoneme conversion rules or by analogy to other words.[1] Because subjects are likely to have encountered high-frequency names before, even if they are not names of famous people, it is only low-frequency, unfamiliar names for which the direct route from recognition units to phonological output codes is unlikely to be available. Therefore, it is predicted that high-frequency, unfamiliar names will be named faster than low-frequency, unfamiliar names.

[1]In drawing an analogy between names, words and faces it is assumed that the locus of the effect of frequency and familiarity is at the stage of identification of a familiar stimulus (i.e. activation of a recognition unit). Monsell et al. (1989) make the point that if a word is read by assembling pronunciation, the source of frequency sensitivity in identification is by-passed. The processes by which pronunciation of an unfamiliar word is assembled may also be frequency sensitive, but this is a different locus of an effect of frequency.

Accessing a phonological output code via the recognition unit route requires unique identification of the name. Because unique identification is believed to be frequency sensitive, it was predicted that high-frequency, familiar names would be named faster than low-frequency, familiar names. The relative magnitude of the effect of frequency on naming familiar and unfamiliar names is not easily predictable, because in the former case it arises from the frequency sensitivity of the direct route from recognition units and in the latter case it arises from the use of different routes.

Method

Subjects. A total of 24 students from the University of Cambridge acted as subjects, 3 of whom were female and 21 of whom were male. None had taken part in any of the other experiments reported here.

Stimuli. The 40 British names used in Experiment 1 served as the stimuli in this experiment.

Apparatus. The appartus was the same as used in Experiment 1, except that reaction time was determined by use of a voice key. The data logged on any trial could be "cancelled" by a push button operated by the experimenter. This was used to cancel trials on which the subject either read the name incorrectly or the voice key was triggered by some other sound.

Design. There were two within-subjects factors, familiarity and frequency of the names. There were 10 stimuli in each of the four cells of the design. The dependent variable was the reaction time. The stimuli were presented in a random order. Four different random orders were used. Six subjects were tested with each order of stimuli.

Procedure. The procedure was the same as for Experiment 1 except for the following details. The subjects' task was to read aloud the surname only as quickly as possible. There were 20 practice trials at the start of the session. Ten of the stimuli in the practice trials were famous names, ten were unfamiliar names. There was a 10-sec pause after the practice trials before the 40 experimental trials were presented in a single block.

Results

Errors were recorded on 5.2% of trials, either because the name was pronounced incorrectly, misread or because the voice key was triggered before the subject read the name. Accuracy data were not analysed

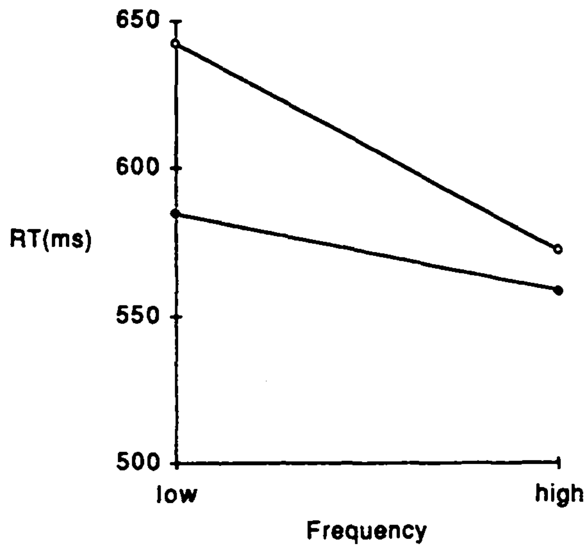

FIG. 4. **Mean naming latency for names as a function of familiarity and frequency (Experiment 2). ●, Familiar; ○, unfamiliar.**

further. Mean naming latencies are shown in Fig. 4. The naming latencies were subjected to an ANOVA with familiarity and frequency as within-subjects factors. There was a main effect of familiarity [$F(1,23) = 30.51$, $P < 0.001$]: names of famous people were named faster than unfamiliar names. There was also a significant main effect of frequency [$F(1,23) = 80.20$, $P < 0.001$], i.e. high-frequency names were named faster than low-frequency names. The interaction between frequency and familiarity was significant [$F(1,23) = 10.06$, $P < 0.005$]. The simple main effects of this interaction were analysed using Tukey HSD tests. There was an effect of familiarity on naming of low-frequency names ($P < 0.01$), but not on high-frequency names (HSD = 19.4 msec). There was an effect of frequency on both familiar names ($P < 0.01$) and unfamiliar names ($P < 0.01$; HSD = 17.9 msec).

An items analysis of the naming latency data was also carried out. A main effect of familiarity [$F(1,36) = 4.64$, $P < 0.05$] and a main effect of frequency [$F(1,36) = 5.51$, $P < 0.05$] were found. The interaction term was not significant in the items analysis ($F = 1.07$).

Discussion

The results of Experiment 2 are consistent with the predictions based on names being represented within the lexicon of a recognition unit model of word recognition. High-frequency, familiar names were named faster than low-frequency, familiar names. This effect is consistent with unique identification of words being frequency-sensitive. An effect of frequency was also found on RT to name unfamiliar names. This is assumed to reflect the likely need to assemble pronunciation for low-frequency, unfamiliar names but not for high-frequency, unfamiliar names. The analysis by subjects provided some evidence that the use of different routes for naming unfamiliar names produced a greater effect of frequency than did the frequency sensitivity of unique identification of word recognition units for naming familiar names. However, this interaction was not supported by an analysis by items.

No effect of familiarity was found for naming latency of high-frequency names. An effect would be expected to the extent that the combined effect of frequency and familiarity would be greater for high-frequency, familiar names than for high-frequency, unfamiliar names. However, it is again important to point out that the familiarity × frequency interaction was not supported by the items analysis. In addition, any effect of familiarity for high-frequency names is more likely to be contaminated by the names of people personally familiar to individual subjects. It is possible that the failure to find an interaction in the items analysis was due to the low power of the items analysis in which the factors are between-items and there are only 10 items per cell.

EXPERIMENT 3

Introduction

In Experiment 3, the effect of frequency on a name familiarity decision task was explored. The task requires a subject to decide whether or not a name is that of a familiar (i.e. famous) person. It should be noted that in this task, unlike the tasks used in Experiments 1 and 2, a different response is required to familiar and unfamiliar names. Therefore, the effect of name familiarity *per se* cannot be investigated independently of any factors affecting the different response types. The name familiarity decision task is directly analogous to the face familiarity decision task which has been used extensively in the face recognition literature. The face familiarity decision task was developed as a task analogous to the lexical decision task in the word recognition literature (Bruce, 1983).

A major difference between the name familiarity decision task and the nationality decision and naming tasks, is that the familiarity decision task requires the subject to access memory for familiar individuals. The nationality task and naming task required a response that was independent of familiarity. Therefore, effects of familiarity were incidental to the task demands. The familiarity decision requires subjects to decide whether a name is of a familiar person and so the decision is assumed to be based on the output of name recognition units, and to require unique identification.

Reaction time in a lexical decision task is faster to high-frequency words than to low-frequency words. If name frequency is directly analogous to word frequency, it would be expected that high-frequency names would be accepted as familiar faster than low-frequency names. However, if it is assumed that there is a name recognition unit for every familiar individual, a high-frequency name will lead to activation of many recognition units. In contrast, a low-frequency name will cause activation restricted to a few recognition units. Therefore, when a low-frequency name is presented, it will be easier to detect that the stimulus matches the stored representation of a familiar individual name because there will be less "noise" from the units representing other individuals with the same name. Young and Ellis (1989) propose an analogous account of the effect of distinctiveness on face familiarity decision (Valentine & Bruce, 1986a; 1986b).

Method

Subjects. A total of 24 students acted as subjects, 6 of whom were female and 18 of whom were male.

Stimuli. The 40 British names used in Experiments 1 and 2 served as stimuli.

Apparatus. This was the same as Experiment 1.

Design. The design had two within-subjects factors, familiarity and frequency of the names. There were ten stimuli in each of the four cells of a 2 × 2 design. The subject's task was to decide whether each name was that of somebody familiar to him/her. The dependent variable was RT in a "yes/no" decision.

Procedure. The procedure was the same as Experiment 1, except for the following details. There were 20 practice trials followed, after a break, by the 40 experimental trials. The subjects were informed that some of the names they would see were celebrities' names and some would be unfamiliar. They were instructed to press the "yes" button if the name was familiar, and the "no" button if it was not. They were also instructed to respond as quickly and as accurately as possible. As in Experiments 1 and 2, initial and surnames were presented.

Results

It is impossible to discuss the "error rate", because it is possible that a subject responded "no" to a name rated as familiar because the name was genuinely unfamiliar. However, "disagreements" only occurred on 8.9% of trials. Accuracy data were not analysed further. The mean correct RTs are plotted in Fig. 5. Separate analyses of "yes" and "no" responses were carried out. A single factor ANOVA of correct "yes" responses revealed a significant effect of frequency [$F(1,23) = 7.45$, $P < 0.05$]. Low-frequency, familiar names were accepted faster than high-frequency, familiar names. An ANOVA of correct "no" responses also revealed a significant main effect of frequency [$F(1,23) = 12.25$, $P < 0.01$]. Low-frequency, unfamiliar names were rejected faster than high-frequency, unfamiliar names. An ANOVA of all the RT data, taking familiarity as a factor, was also carried out. There was a significant main effect of frequency [$F(1,23) = 18.59$, $P < 0.001$] and a significant main effect of familiarity [$F(1,23) = 21.92$, $P < 0.001$]. "Yes" responses were faster than "no" responses. The frequency × familiarity interaction was not significant [$F(1,23) = 2.00$, $P > 0.15$].

An analysis by items was also carried out. A 2 × 2 ANOVA with familiarity and frequency as between-items factors, gave a significant main effect of familiarity [$F(1,36) = 23.2$, $P < 0.001$], but the main effect of

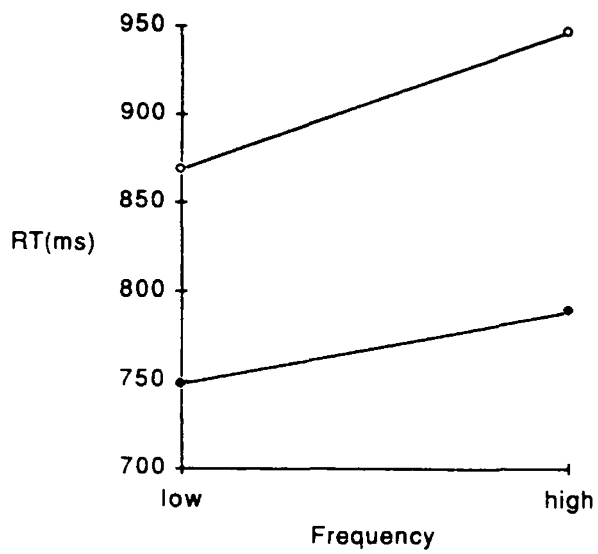

FIG. 5. Mean reaction time of correct responses in a name familiarity decision task as a function of familiarity (yes *vs* no responses) and frequency (Experiment 3). ●, Familiar; ○, unfamiliar.

frequency just failed to reach statistical significance [$F(1,36) = 3.70$, $P = 0.06$]. The interaction between familiarity and frequency was not significant ($F < 1$).

Discussion

The results from Experiment 3 have demonstrated that a name familiarity decision can be made more rapidly to a low-frequency name than to a high-frequency name. This effect of frequency was found for the RT to accept familiar names and for the RT to reject unfamiliar names. The main effect of frequency did not quite achieve statistical significance in the items analysis, but it is possible that this is due to the low statistical power of the items analysis. Frequency is a between-items factor, with only 10 observations per cell in the items analysis.

The effect of name frequency found in the familiarity decision task is the reverse of the effect of name frequency on the nationality and naming latency tasks. There was an advantage for high-frequency names in the nationality decision and naming tasks, but there was an advantage for low-frequency names in the familiarity decision task. The critical aspect of the familiarity decision task is that it requires access to memory for specific individuals, whereas the other tasks do not. Performance in the nationality and naming tasks depended on the combined effects of familiarity and frequency, and the results were analogous to the effects of frequency on word recognition. In the familiarity decision task, the specificity of a name to a familiar individual appears to be critical, giving rise to an advantage for low-frequency names. This result is consistent with familiarity decision being based on the output of name recognition units. In this task, the effect of name frequency appears analogous to the effect of distinctiveness in face familiarity decision (Valentine & Bruce, 1986a; 1986b). Distinctiveness of faces and frequency of names both determine the "spread" of activation across recognition units representing different individuals' faces or names.

The name recognition unit account of the effect of name frequency implies that it is the ambiguity of names that gives rise to the advantage of low-frequency names in a name familiarity decision task. Therefore, the use of less ambiguous stimuli, for example first and surnames, should reduce or remove the effect of frequency in name familiarity decision. This prediction was tested in Experiment 4.

EXPERIMENT 4

The aim of Experiment 4 was to investigate further the effect of name frequency in the familiarity decision used in Experiment 3. There were two experimental conditions in Experiment 4: in one condition the stimuli consisted of a first and surname (condition 1), and for a different group of subjects, the stimuli were an initial and surname (condition 2). It was predicted that the effect of frequency would be reduced for full names.

Method

Subjects. A total of 32 undergraduate students (18 females and 14 males) participated. All were native French-speaking Belgians. Sixteen subjects were randomly assigned to each experimental condition.

Stimuli. Twenty full names of famous people and 20 invented (unfamiliar) names were used. In each of these two categories of names, there were 10 high-frequency surnames and 10 low-frequency surnames. Familiarity ratings (for the familiar names) were obtained from an independent sample of 40 subjects who rated the names using a 7-point scale (1 = unfamiliar, 7 = highly familiar). Other real surnames and the same first names as those of the celebrities were used to construct the unfamiliar names used in condition 1. The unfamiliar names consisted of a first and surname combined in such a way that the full name was not that of a famous person (at least from the experimenter's viewpoint). A surname was judged to be of high frequency if it appeared at least once in 5000 entries, and to be of low frequency if it appeared less than once in 45,000 entries in the Liege area telephone directory. Details of familiarity, frequency and the number of letters in the names in each cell of the design are given in Table 2. The same stimuli were used in condition 2, except that each first name was replaced by the appropriate initial.

Apparatus. A COPAM PC88C microcomputer was used to control stimulus presentation, random order generation and to log responses and RTs.

Design. The format of the names presented was a between-subjects factor. The frequency (high/low) and familiarity (famous/unfamiliar) of the names formed two within-subjects factors. Response latency was the dependent variable.

Procedure. The stimuli were presented on the computer screen in a different random order for each subject. The experiment was preceded by a short practice session using eight names that did not appear later in the experiment. The response keys were located on the keyboard. The left and right position of the "yes" and "no" response keys was counterbalanced across subjects. Other aspects of the procedure were the same as for Experiment 3.

TABLE 2
Mean Familiarity Ratings, Frequency (Occurrences per 100,000 Entries) and Number of Letters in Full and Surname of the Belgian Names Used in Experiment 4 (standard deviations are shown in parentheses)

	Familiar Names		*Unfamiliar Names*	
	High-frequency	*Low-frequency*	*High-frequency*	*Low-frequency*
Familiarity	5.26 (0.43)	5.33 (0.76)	—	—
Frequency	56.81 (27.09)	0.98 (0.83)	56.44 (24.49)	0.83 (0.23)
No. of letters, full names	13.00 (2.41)	13.80 (2.64)	13.50 (1.28)	13.80 (1.47)
No of letters, surnames	6.30 (1.19)	6.50 (2.01)	6.70 (1.62)	6.50 (1.21)

Results

Separate analyses were carried out on RTs to accept names of famous persons and on RTs to reject unfamiliar names. The number of "no" responses to famous names was low (5.6% in condition 1 and 6.9% in condition 2). These "incorrect" RTs and two correct RTs over 2 sec were treated as missing data. The mean correct RTs to the high- and low-frequency, familiar names were calculated for each subject. The data are shown in Fig. 6.

A 2 (condition) × 2 (frequency) ANOVA with repeated measures on the last factor was carried out on the mean RT to accept famous names. The main effect of condition was not significant ($F < 1$), nor was the main effect of frequency [$F(1,30) = 2.22$, $P > 0.1$]. However, there was a significant interaction between the two factors [$F(1,30) = 7.99$, $P < 0.01$]. Tukey HSD tests revealed that frequency had no significant effect when full names were presented, but RTs to high-frequency names were slower than RTs to low-frequency names in the initial and surname condition [$P < 0.01$, HSD (0.01) = 66 msec].

An analysis by items was also carried out. A 2 × 2 ANOVA with condition and frequency as between-items factors showed no main effect of condition or frequency (both F ratios < 1) and only a tendency for an interaction [$F(1,36) = 3.20$, $P < 0.08$].

The number of unfamiliar names incorrectly accepted as familiar was small (5.3% in condition 1 and 6.9% in condition 2). These "yes" responses and 13 correct RTs over 2 sec were treated as missing data. The mean correct RTs to unfamiliar names are plotted in Fig. 7. These data

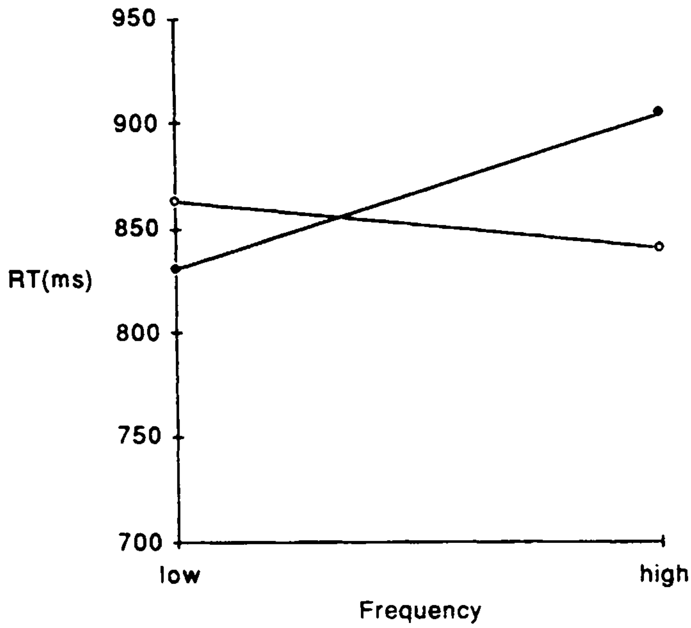

FIG. 6. Mean reaction time of correct responses to familiar faces in a familiarity decision task as function of format of name and frequency (Experiment 4). ●, Initial + surname; ○, full name.

were subjected to a 2 (condition) × 2 (frequency) ANOVA. The analysis revealed no main effect of condition ($F < 1$), a significant main effect of frequency [$F(1,30) = 60.87$, $P < 0.001$] and no interaction [$F(1,30) = 2.71$, $P > 0.1$]. RT to reject unfamiliar names was longer for high-frequency names (mean 1045 msec) than for low-frequency names (mean 922 msec). Mean correct RTs to reject unfamiliar faces were also analysed by item. The only significant effect was the main effect of frequency [$F(1,36) = 21.061$, $P < 0.001$]. Other F ratios were less than 1.3.

Discusssion

Experiment 4 replicated the results of Experiment 3, using an entirely different set of stimuli which were drawn from a different linguistic community. In both Experiments 3 and 4, familiarity decisions to familiar and unfamiliar initial and surname combinations were faster for low-frequency names than they were for high-frequency names. In Experiment 4, presentation of first and surnames was found to remove the effect of surname frequency on RT to accept familiar names but not on RT to reject unfamiliar names.

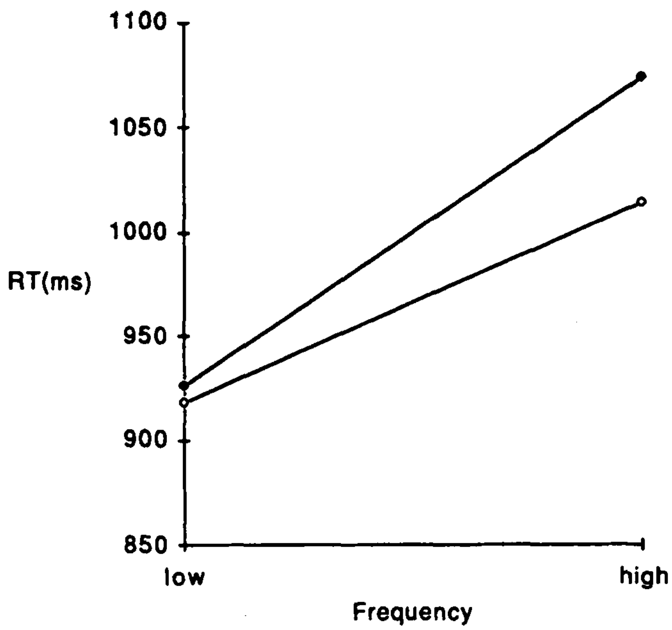

FIG. 7. Mean reaction time of correct responses to unfamiliar faces in a familiarity decision task as function of format of name and frequency (Experiment 4). ●, Initial + surname; O, full name.

The results of familiarity decisions to full names are consistent with the interpretation of frequency effects in terms of "noise" from competing name recognition units. A first and surname provides a much less ambiguous cue to an individual than an initial and surname. When coupled with a first name, the appropriate name recognition unit will be more highly activated, and name recognition units for individuals who share the same surname will be less highly activated than they would be following presentation of an initial and surname. Therefore, including first names reduces the "noise" from competing units and so removes the effect of frequency of the surname. It is interesting to note that there is an effect of frequency on rejection latency for unfamiliar first and surname combinations. In this case, there is not a single recognition unit that will be strongly activated by the particular first and surname combination, but for the high-frequency surnames there are likely to be more name recognition units for individuals who share the same surname which will be activated to some extent. In the absence of one very strongly activated unit, the greater amount of activity in these other units induced by a high-frequency surname is sufficient to slow down the rejection of a high-frequency name compared to the RT to reject a low-frequency name.

The account of the effect of frequency on familiarty decision discussed so far assumes that familiarity decision requires unique identification of an individual. The RT in a familiarity decision is assumed to depend upon a ratio or a relative threshold of activity of a particular unit above that of competing units. The familiarity decision task does not logically require unique identification, although the interpretation of frequency effects described assumes that in practice name familiarity decisions are based on unique identification. However, logically, it could be possible to perform the task on some level of a familiarity signal, without the need to identify a particular unit as the source of the activity. If such a familiarity signal – which was not specific to an individual – was the basis of familiarity decisions, an advantage for high-frequency names would be expected, as found in the nationality decision task (Experiment 1) and naming task (Experiment 2). Experiment 5 was run as a check on our interpretation of the frequency effects on familiarity decision. A semantic classification task was used in which familiar names have to be classified as politicians or TV personalities (Young et al., 1986b; 1986c). This task requires unique identification of an individual and access to identity-specific semantic information in order to classify the individual according to their occupation (Bruce & Young, 1986). We have argued that the locus of frequency effects in processing names is at the stage of unique identification at the level of name recognition units. Therefore, it is predicted that a semantic classification will show the same effect of frequency as familiarity decision. There is no *a priori* reason to suppose there would be any additional effect of frequency on the access to identity-specific semantic information.

EXPERIMENT 5

Method

Subjects. A total of 12 French-speaking Belgian undergraduates participated in the experiment.

Stimuli. Sixteen of the 20 famous names used in Experiment 4 served as stimuli. Initial and surnames were used. Eight high-frequency and eight low-frequency names were selected such that there were four politicians and four TV personalities in each frequency category. The mean familiarity scores were 5.35 for the high-frequency names and 5.45 for the low-frequency names. The mean frequencies (per 100,000 entries) were 61.27 and 0.95 respectively.

Apparatus. This was the same as for Experiment 4.

Design and Procedure. There were two within-subjects factors, frequency and occupational category. The subjects' task was to decide whether each name was that of a politician or a TV personality. The two response keys on the keyboard were labelled "TV" and "POL". Other aspects of the design and procedure were the same as for Experiment 4.

Results

The mean correct RTs for each set of four stimuli were calculated and are plotted in Fig. 8. The error rate was low (4.16%). The errors and five correct RTs over 2 sec were treated as missing data.

A 2 × 2 ANOVA with repeated measures on both factors was carried out. The analysis showed a main effect of frequency [$F(1,11) = 26.08$, $P <$ 0.01], the high-frequency names being classified more slowly than the low-frequency names. No other effects were significant (both F ratios < 1.4). The same pattern of results was found in an analysis by items. There was a main effect of frequency [$F(1,12) = 30.15$, $P < 0.001$], but the main effect of occupation just failed to reach significance [$F(1,12) = 4.12$, $P < 0.07$]. The interaction was not significant ($F < 1$).

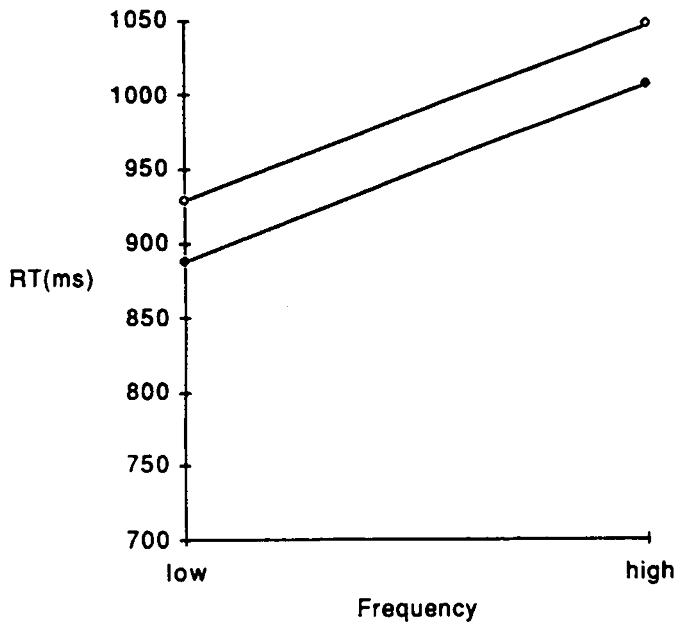

FIG. 8. Mean reaction time in semantic classification of familiar names as a function of occupational category and frequency (Experiment 5). ●, Politicians; O, TV personalities.

Discussion

Experiment 5 has shown that RT in a semantic classification is faster for low-frequency surnames than for high-frequency surnames. Thus the effect of frequency on semantic classification is similar to the effect of frequency on familiarity decision.

The model of face (and person) recognition in Fig. 1 predicts that semantic classifications would take longer than familiarity decisions because access to identity-specific semantics is required for semantic classification but not for familiarity decision. Young et al. (1986c) found that familiarity decisions to faces could be made faster than semantic classification of faces. Although a formal analysis of the data from the initial and surnames condition of Experiment 4 and Experiment 5 is not possible due to differences between the designs, an informal comparison of the RTs does support the theoretical prediction. The mean RT to correctly accept a name as familiar was faster than the mean RT to classify a familiar name according to the person's occupation (868 and 968 msec respectively).

GENERAL DISCUSSION

There are a number of empirical conclusions which can be drawn from the experiments reported:

1. RT in a nationality decision task was faster for high-frequency surnames than for low-frequency surnames if the initial and surnames were not of familiar individuals. Frequency of surname did not affect RT of nationality decision to familiar initial and surname combinations.
2. Naming latency is faster to high-frequency than to low-frequency surnames, both for familiar and unfamiliar initial and surname combinations.
3. RT to accept initial and surnames as familiar or reject them as unfamiliar is faster to low-frequency surnames than to high-frequency surnames. The effect of frequency on RT to accept familiar names is restricted to names presented as an initial and surname, but the effect of frequency on RT to reject unfamiliar names is found for full names and initial and surname stimuli.
4. Low-frequency, familiar initial and surname combinations are classified according to the person's occupation faster than high-frequency, familiar initial and surnames.

The experiments reported here provide evidence to support the proposed framework of processes involved in recognising people's names. The data are consistent with a framework in which it is assumed that names and words are represented by word recognition units, there being one unit for every familiar word or name. The output of word recognition units which represent names, connect to a set of name recognition units in which there is a unit for every familiar individual. Activation of name recognition units allows access to identity-specific semantics which can also be accessed through the face recognition system. In tasks which do not require identification of individuals, the combined effects of familiarity and frequency of names are analogous to word frequency effects in word recognition. In tasks which do require identification of individuals, the effect of name frequency is analogous to the effect of distinctiveness in face recognition. Although the effect of the degree of familiarity of names in a familiarity decision task has not been investigated here, it is predicted that the effect of familiarity of names would be analogous to the effect of familiarity of faces. RT in a face familiarity decision is faster for more familiar faces (Valentine & Bruce, 1986a). The analogous effect of familiarity of names in a name familiarity decision task would be predicted.

In Fig. 1, the phonological output codes for words and people's names are shown as sharing a common box because we know of no evidence which requires output codes for words and people's names to be separated. Young et al. (1986b) found that written familiar names could be read aloud faster than rearranged names. Subjects were faster to name "Jack Nicholson" and "Dean Martin" than they were to name "Dean Nicholson" and "Jack Martin". The advantage for familiar names could result from associative priming between word recognition units representing first and surnames (via the links to name recognition units). Alternatively, or in addition, there could be associative priming between phonological output codes. It is also possible that a similar (purely associative) effect could exist for words that often occur together in common phrases or expressions. Similarly, word recognition units for names and for words which are not used as names have not been distinguished in Fig. 1. We know of no evidence to force such a distinction to be made. Further research would be required to justify fractionation between names and words at the level of input units (word recognition units) or phonological output units.

The experiments reported here provide some initial evidence for a functional model of face, name and word recognition. Although the framework has been described in terms of a conventional information-processing model, we do not see any of the data presented as being inconsistent with an implementation in terms of a model based on cascade processes or parallel distributed processing.

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APPENDIX

Stimuli Used in the "British" Condition of Experiment 1 and in Experiments 2 and 3

Familiar		*Unfamiliar*	
High-frequency	*Low-frequency*	*High-frequency*	*Low-frequency*
L. Piggott	A. Scargill	A. Murfitt	H. Otway
S. Coe	T. Wogan	R. Stock	G. Twigger
R. Burton	S. Cram	K. Swann	P. Rolt
P. Newman	R. Redford	D. Farrant	P. Solder
K. Everett	F. Bruno	G. Webster	A. Brunwin
M. Jackson	B. Sheen	M. Sharp	J. Oatham
J. Archer	G. Orwell	R. Morgan	B. Todman
K. Williams	R. Mayell	S. Hall	G. Keetch
B. Reynolds	M. Jagger	B. Simpson	R. Waycot
G. Howe	D. Hurd	K. Wright	K. Padbury

Stimuli Used in Experiment 4. Full Names were Presented in Condition 1 and Initial and Surnames were Presented in Condition 2. These Names (Initial and Surname) were also Used in Experiment 1 except that E. Close was Replaced by S. Rigot. The First Eight Names in the Lists of High- and Low-frequency, Familiar Names Served as Stimuli in Experiment 5

Familiar Names		*Unfamiliar Names*	
High-frequency	*Low-frequency*	*High-frequency*	*Low-frequency*
Dominique Wathelet	Georges Moucheron	Dominique Goffart	Geores Bedoret
Mamine Pirotte	Philippe Geluck	Mamine Compere	Philippe Latet
Michel Lecomte	Jacques Bredael	Michel Laval	Jacques Gomand
Theo Mathy	Joseph Buron	Anne-Marie Maes	Joseph Limelette
Ann-Marie Lizin	Phillipe Monfils	Theo Lempereur	Philippe Lehyme
Philippe Moureau	Antoinette Spaak	Philippe Delhez	Antoinette Rondis
Willy Claes	Jean Gol	Willy Boulanger	Jean Spelters
Gerard Deprez	Andre Bertouille	Gerard Melon	Andre Plumat
Edouard Close	Philippe Maystadt	Edouard Fontaine	Philippe Mouthuy
Michel Hansenne	Jean-Pierre Grafe	Michel Closset	Jean-Pierre Miron