# Semantic structure of personal information.

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# DECLARATION

I declare that this thesis is my own work carried out under the normal terms of supervision.

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Allan McNeill

# PUBLICATIONS

Chapters 4 and 5 of this thesis have been submitted for publication.

Chapter 4

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Chapter 5

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# ABSTRACT

A sequential arrangement of processing stages is incorporated into most theoretical models of person recognition (e.g., Bruce & Young, 1986). Simple familiar/unfamiliar decisions are earliest, followed by access to semantic information, followed by naming.

To date, the stage involved in semantic decisions has received least attention. Thus, relatively little is known about how we store personal semantic information. More research into this stage is necessary if we are to better understand the organisation of semantic memory for familiar people. The primary aim of this dissertation is to provide new evidence relating to the storage and retrieval of such information.

The first line of enquiry attempts to discriminate between two influential models in this area (Burton et al., 1990 and Brédart et al., 1995), by using a new method involving semantic judgement tasks in the traditional semantic priming paradigm. In one model (Burton et al., 1990), semantic information is stored in a single undifferentiated pool. In the other model (Brédart et al., 1995) semantic information is clustered into separate pools. The two types of account make different predictions about certain patterns of priming during information retrieval. The experiments reported here fail to discriminate between the models.

Later experiments identify the locus of the reported semantic priming effects and provide an explanation of these findings within a structural model of person recognition.

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# CHAPTER ONE

## INTRODUCTION

There is probably no other visual stimulus that we look at more often than the human face. It provides us with a wealth of important information. We can immediately determine the person's sex and other information such as age and expression. Bruce and Young (1986) refer to this type of information as "visually derived semantic information" and this is available in every face we encounter. Determining whether someone is, say, British or American, is another problem entirely. The first type of information can be extracted from the face itself and is equally available, irrespective of whether or not the person is known to us or is a complete stranger. The second type of information is only available for people that are known to us. Bruce and Young (1986) refer to this type information as identity-specific semantic information. This thesis is concerned with such identity specific semantic information.

On seeing a photograph of, say, Sigmund Freud, we are able to access a great deal of information about him: we may recognise the face as being familiar; we may realise that it belongs to an Austrian psychologist; and finally we might remember his name. Converging evidence from diary studies (Young, Hay, & Ellis, 1985), neuropsychology (e.g.,Flude, Ellis, & Kay, 1989) and experimental psychology (e.g.,Young, Mcweeny, Ellis, & Hay, 1986; Young, Mcweeny, Hay, & Ellis, 1986) appears to support the time course of the processing stages described above. Simple familiar/unfamiliar decisions are fastest, followed by access to semantic information, followed by naming. This sequential arrangement of processing stages is incorporated into most theoretical models of person recognition (Bruce & Young, 1986; Burton, Bruce, & Johnston, 1990; Hay & Young, 1982) and a consensus overview of the person recognition system is beginning to emerge.

By comparison to the other stages outlined above, there is relatively little data relating to the stage involving semantic decisions. How do we store information about people that we know? More information regarding this stage is necessary if we are to understand the organisation of semantic memory for familiar people. The primary aim of this thesis is to provide new evidence relating to the storage and retrieval of such information.

However, in order to examine the structure of the semantic system pertaining to familiar people we must begin by addressing more fundamental issues. For instance, is personal information about people stored in a unitary semantic system along with other abstracted general knowledge? Is this information stored in a person specific semantic system? Is recognising a person (at least from their face) a series of modular processes, in the sense proposed by Fodor (1983), or is it simply expertise (e.g. Gauthier, Skudlarski, Gore, & Anderson, 2000). If face recognition is a series of modular processes, does recognition in other modalities (e.g., name, voice, gait) tap this same system at some point (perhaps at the level of person identification rather than face identification), or is recognition in these modalities mediated by a completely separate sets of processes? Do these modular type systems (should they exist) have their own modality specific semantic stores, or do they share access to some person specific system, or perhaps even a more global general system? Finally do any of these postulated, abstractive, semantic systems actually exist, or do we code all information episodically, as a series of memory traces. In order to answer these questions we will draw on evidence from a wide variety of sources including: experimental psychology, cognitive neuroscience, and cognitive modelling. I will begin by considering recent theories relating to the structure of semantic memory.

## THEORIES OF SEMANTIC MEMORY

The question addressed here is whether or not semantic memory forms a unitary system. One way to infer the workings of any cognitive system is to look at how normal processing breaks down in brain damaged individuals.

Neuropsychological double dissociations have traditionally played an important role in determining how normal processing breaks down. This type of evidence has been used very effectively to demonstrate that semantic memory can be impaired in one domain of knowledge while another remains relatively unimpaired. Such findings alone indicate that there is some type of categorial organisation of conceptual knowledge; but what might the categories of such categorial organisation be? Perhaps the most common of such semantic deficits is for living things (Warrington & Shallice, 1984). The reverse pattern (a deficit for non-living things) while less common has also been reported (e.g. Hillis & Caramazza, 1991). One might postulate three main types of explanation for this double dissociation.

*Domain specific organization*

The first suggests that there may be physically and functionally independent stores in the brain for different categories of knowledge (e.g. Caramazza & Shelton, 1998). These authors claim that certain conceptual categories represent evolutionarily adapted domain-specific knowledge systems that are subserved by distinct neural mechanisms. The categories, which these authors offer as being determined by evolutionary adaptation, are animals, plant life and artifacts. In a later article Caramazza (2000) relegates artifacts to a possible category, and advances conspecifics as a primary plausible category along with animals and plant life. These categories are suggested (by Caramazza) on the basis that the fitness value of such adaptations is uncontroversial. For example, animals are potential predators and a source of food, plants are a source of food and medication, and conspecifics are source of nurturance and protection. These authors argue that further structure within these broad domains of knowledge is not categorical in form, but reflects the correlational properties of its members (see,Caramazza & Hillis, 1990; Hillis, Rapp, & Caramazza, 1995; and for a related postion see, Riddoch, Humphreys, Coltheart, & Funnell, 1988). Clearly such a position is speculative and is based largely on the perceived failure of other models in this area to account for wide-ranging patterns category-specific deficits found in the patient population (for review see original paper, Caramazza & Shelton, 1998). However, to continue in a speculative vein, adding faces (our primary source of information for recognising and categorising people) to the categories which are determined by evolutionary adaptation, is not an unreasonable proposition. Such theorising, leads to the possibility that a specialised semantic system, coding personal information, may exist.

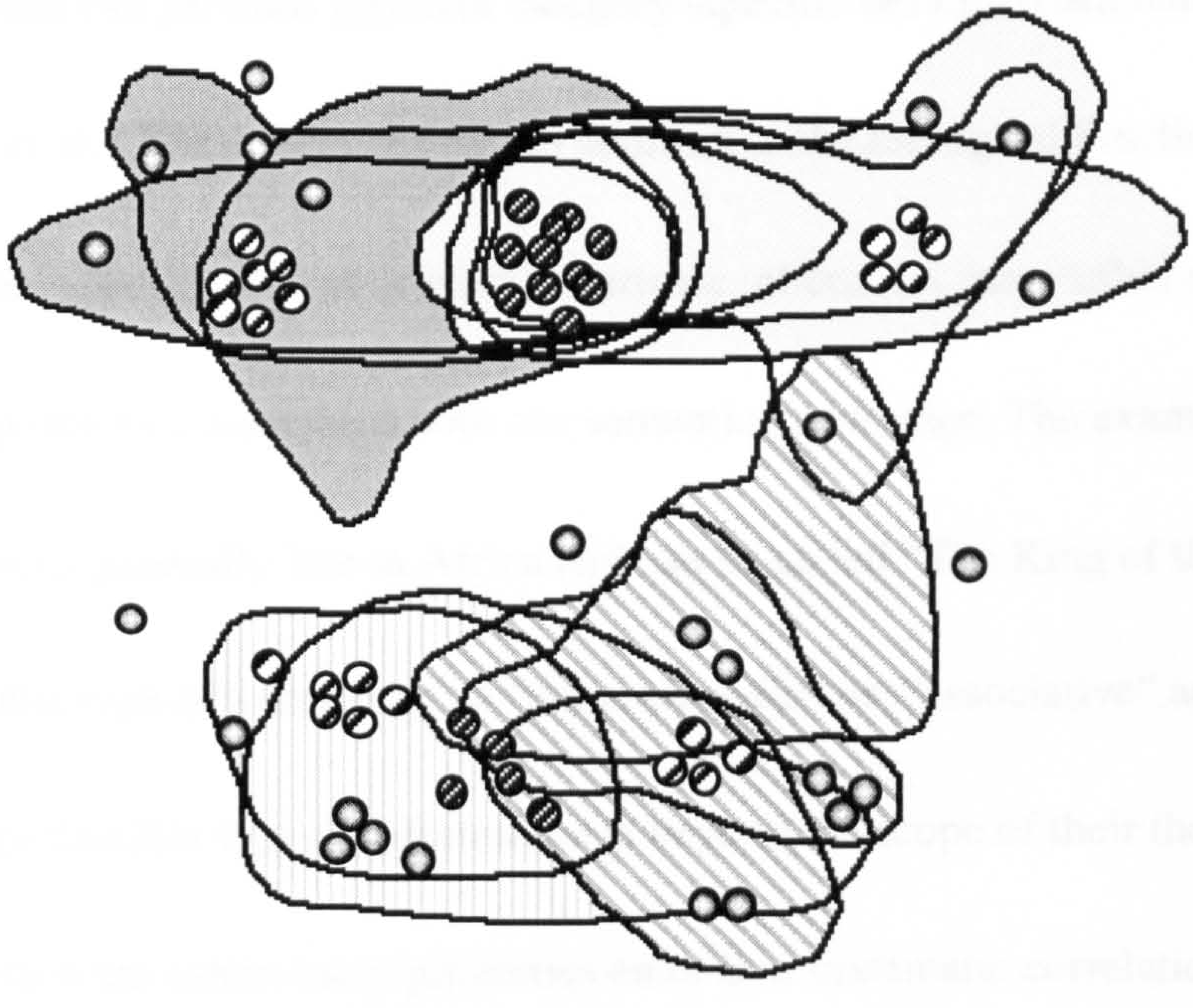
*Modality specific organization*

The second position suggests that concepts may vary by modality, depending on the type of semantic information on which they rely. Thus, living things may depend more on information from the sensory modality, and artifacts may depend more on functional properties (Warrington & Mccarthy, 1983; Warrington & Mccarthy, 1987; Warrington & Shallice, 1984). This type of account assumes that processors are specialised for type of property, rather than for semantic category per se. According to this type of account, selective damage to one type of semantic information will lead to an apparent category-specific deficit. It should be noted here that recasting the living/nonliving distinction, in terms of the relative contributions of perceptual and functional properties, does not, in fact, alter the basic claim that category-specific deficits are associated with damage to distinct stores of knowledge. It is simply that now the content of these stores is determined, not by category membership, but by information type (perceptual or functional).

*Unitary Semantic System*

Finally, and most recently, is the suggestion that these category-specific deficits may emerge from the internal structure of the concepts alone, without the need for neural or functional specialisation (Tyler, Moss, Durrant-Peatfield, & Levy, 2000).

In this framework, apparent category-specific deficits are held to result from damage within a unitary semantic system. This theory suggests that the observed patterns of impairment result from a complex interaction of type of semantic feature, correlations between features, and the extent to which features are shared or distinctive. A feature that is present in only one concept can be used to identify uniquely that concept. If a feature (say, wings) is shared by a large number of concepts (e.g., sparrow, chaffinch, rook, penguin, eagle, etc), it becomes a relatively poor marker for each particular concept. By their nature, correlation and distinctiveness tend to be inversely related. Highly correlated features (e.g., wings) are often present in many concepts, and as such are not very distinctive. Such a property would be resistant to damage, but its preservation in a damaged system would be more useful for identifying the category to which an item belongs, rather than in distinguishing it from other category members. On the other hand, distinctive features (at least those that fail to correlate with other properties) will be very vulnerable to damage. However, those distinctive features that do correlate, especially with other distinctive features, will protect the concept to which they belong. Tyler and colleagues suggested differential correlation patterns between semantic features for living things and artefacts can provoke exactly the type of dissociation normally observed between these categories. Evidence in support of this theory is provided in a PDP model, which learns complex correlation patterns that are defined by the inherent nature of living things and artefacts and by their perceptual and functional relationships.



*From Tyler et al. (2000).*
Proposed clustering of correlated features, and the differences in structure for concepts in the living and non-living domains, as predicted by the conceptual structure model. Each concept is represented as a pattern of activation over a set of features. Living-things concepts (solid grey) have many highly intercorrelated features (represented by white-striped circles) shared by all members of the domain and many intercorrelated properties shared by all members of a category, such as birds or mammals (represented by light grey versus dark grey concepts). Concepts also have some distinctive features (target circles), but these do not tend to be highly correlated with each other. Artifacts (horizontal stripes) have fewer, less densely intercorrelated properties ateither the domain or category level. Therefore categories within the domain (e.g. tools, weapons, vehicles) form less well-defined clusters. However, distinctive properties tend to occur in small highly intercorrelated groups; that is, the presence of one property predicts the presence of another within the concept. In this way, domains and categories form 'lumps' within semantic space, but there is no clear cut-off between them.

Essentially this account views the brain as a system, adapted to encode the functional and statistical regularity of the world around it. The statistical properties in the perceptual surroundings produce different patterns of distinctiveness and correlation in the systems internal representations. These patterns of internal representations can produce apparent category–specific deficits when damaged.

Tyler et al. (2000) point out that in addition to the biological functions of living things and the specific uses of artefacts, there are, of course, many other non-perceptual properties associated with our semantic knowledge. The example that they use is that lions generally live in Africa and can be called "The King of the Jungle". They label this type of knowledge as "encyclopaedic" or "associative" and acknowledge that this type of information is beyond the scope of their theory, since it is not clear to what extent these properties enter into systematic correlation with other semantic information. Therefore, Tyler et al.'s theory can offer little insight into the problem of how personal information for familiar people is structured. This becomes clear if we consider the type of information that we might use to define Tony Blair, who generally lives in England and is known as "The Prime Minister of the UK". The type of information that defines Tony Blair is clearly of the type described by Tyler et al. (2000) as "encyclopaedic' or "associative". Theories that appeal to the perceptual/functional distinction are equally unhelpful here. We are not interested in semantic information that is specified either by perceptual of functional properties but in that information which defines biographical properties of the person in question. The question which remains unanswered is can the encyclopaedic type categories, which appear to delineate personal information, be created in an analogous way, using information that we have acquired relating to people. For instance, we see an actor for the first time in a new film. Perceptual type features, such as American (derived from accent), tall, male, could be coded in the normal way using perceptual mechanisms. These types of features could be viewed as similar to the 'wings' example above in that individually they are present in many concepts (e.g., politicians, sports stars, actors, singers, TV presenters, etc.) and are not very distinctive in terms of being unique identifiers of a concept. However, perhaps we also code 'action hero' when we first observe this actor. Such a property could be described as less well correlated but more distinctive and as such would be a better marker for the category of 'movie star'. It is not unreasonable to propose that constellations of known facts relating to people should form statistical regularities that are differentially mapped in some biographical knowledge space. Whether this biographical knowledge space should be seen as separate store, or a 'lump', in Tyler et al.'s unitary semantic space is an open question.

However, the first theory offered above (e.g., Caramazza & Shelton, 1998), which suggested that there may be physically and functionally independent stores in the brain for different categories of knowledge, is perhaps more compatible with what is known about the type of information that is stored relating to familiar people. The basis for this suggestion is contained in the models of person recognition, which will shortly be considered. For the moment, it is acknowledged that any theory relating to the structure of semantic knowledge for familiar people should be compatible with one or other of these more general propositions.

## ABSTRACTIONS OR INSTANCES

Is knowledge represented in an abstract or way or stored as a set of specific instances? This question is central to the fundamental premise on which this thesis is based. There is no doubt that we can retrieve both abstract categories and specific instances form memory, so the real question is how is the information stored.

The abstraction/instance debate has largely focused around competing explanations for repetition and semantic priming effects. Repetition priming occurs when exposure to an item facilitates later processing of that same item. Generally speaking it is long lasting and does not cross stimulus domains. Semantic priming is the facilitation that occurs for a target item when it is immediately preceded by a closely associated item. For example, a lexical decision on a word (e.g., nurse) is faster if it is preceded by an associated word (e.g., doctor). Generally speaking this effect is very short-lived, but does cross stimulus domains. This facilitation is a robust effect occurring for associated words, objects and faces and the ubiquitous nature of this effect suggests that it may have its locus in a fundamental memory retrieval mechanism. How do the competing abstractionist and episodic theories account for these effects?

*Abstractionist Account*

Until quite recently, the most popular explanation of this priming effect appealed to the concept of spreading activation (Anderson, 1976; Collins & Quillian, 1969; Collins & Loftus, 1975; Quillian, 1967). Details may have differed between these theories but the core ideas were essentially the same. According to the models of Collins, Quillian & Loftus (CLQ), knowledge is stored as pieces of abstract information in a network of interconnected nodes, and a specific piece of information can be retrieved from memory when its node becomes active. Activation spreads throughout the network in a cascade fashion, and residual activation at associated nodes facilitates subsequent retrieval of that particular piece of information. Closely related items are grouped closely together, with less well associated items further away, and activation decays with distance and time. For example, processing the word *butter* sends activation to associated concepts such as *bread.* The residual activation at *bread* facilitates its subsequent recognition. However, Ratcliff and McKoon (1981) demonstrated that the time required for activation to spread from one node to another could not be used to explain effects of distance on retrieval time. The same authors (1988, experiment 2), demonstrated that activation decay was also quite rapid (500ms in some circumstances). Taken together, these findings somewhat undermined the CQL style models. It may have been possible to modify them along the lines suggested by Ratcliff and McCoon (1981; 1988), but a new model that fully addressed these issues had already emerged.

The ACT* model proposed by Anderson (1983) could not be criticised on the above grounds. In this model memory is again conceived as a network of nodes and retrieval of a piece of information is consists of activating a particular node. Activation spreads extremely quickly in this model, but nodes only remain active if attention is directed to them, and when attention is shifted activation falls rapidly.

Another difference between this model and the CLQ models involves the priming mechanism. In the CLQ models, residual activation at the target node is maintained even after processing of the prime has stopped. In ACT* the prime and target must be simultaneously active for the association between them to produce heightened activation at the target. While this mechanism could be compared to the compound-cue mechanism suggested by proponents of episodic style accounts (e.g., Ratcliff & McKoon, 1988), this model should not be confused with such accounts, and should clearly be viewed a traditional spreading activation type model.

Taken as a whole, the principle of spreading activation in a semantic network has provided the foundation for a powerful set of theories regarding knowledge representation (e.g., word recognition, Morton, 1979; picture recognition, Warren & Morton, 1982; face recognition, Burton et al., 1990; object recognition, Biederman & Cooper, 1991; Humphreys, Lamote, & Lloyd-Jones, 1995). All of these theories assume that abstract representational units mediate recognition, and that these representations are somehow updated through use. It is this updating (usually observed during the study phase of a typical priming experiment) that allows more efficient or accurate processing at some later stage (test phase of typical experiment).

There are differences within this set of models, but all share the assumption that processing proceeds in stages.

The first stage is visual processing, followed by activation of visual structural representations, followed by access to semantic information, followed by naming. An important aspect of this type of 'stage' model is that it allows detailed predictions regarding how processing might be affected, by task demands that tap the system at the different stages. A particular model in this area (Burton, Bruce, & Hancock, 1999; Burton et al., 1990) will be evaluated later in the section entitled 'Models of Person Recognition'. This evaluation will show that this style of model makes predictions that are incompatible with other theoretical positions.

*Instance Accounts*

The abstractionist position described above does not deny the existence of an episodic system. In fact, it is difficult to see how an abstraction could be constructed without some earlier processing which involves perceiving and remembering instances of exemplars. However, the opposing view, considered here, is that there is only one memory system, which stores an episodic trace for each and every event.

A particular model (Hintzman, 1986) in this class will now be considered in detail. The purpose of evaluating this model is to give a flavour of this type theorising. The various models in this class do differ in detailed respects from one another, but the key idea is constant. Essentially, such theories propose that concepts are not stored as abstracted categories, instead each specific processing episode lays down its own trace.

Hintzman (1986) reports a model (MINERVA 2) which is able to retrieve an abstracted prototype of the category when cued with the category name and to retrieve and disambiguate a category name when cued with a category exemplar. This model, like all in its class, proposes that there is only one memory system, which stores episodic traces of each specific experience. Abstract knowledge as such is not stored but can be derived from the pool of traces at the time of retrieval. This multiple trace theory assumes that each processing episode gives rise to a unique memory trace. Thus, repetition of a word (or a face or an object) does not strengthen a prior representation. Instead, it creates a new trace that coexists in memory with other traces relating to the same item. In this model, there are no abstract representations, only traces of individual episodes that can act in concert at the time of retrieval, to create the impression of stored categories.

In this style of theorising, every experience is assumed to be represented internally, by a set of primitive properties. There are a large number of these properties and they can be accessed via more than one modality. The theory is unclear as to how these primitives are derived but does posit that they are not acquired through experience. The crucial point here is that the number of primitive properties, though large, is much smaller than the number of experiences a person has. Therefore, experiences share primitive properties and the similarity of two experiences is related to the number of properties they share.

Every conscious experience gives rise its own unique memory trace. So seeing the same person over and over again will result in several traces being laid down. Hintzman adopts the terminology of primary memory (PM) and secondary memory (SM) to distinguish between the representation of current experience and the large pool of previously encoded traces. Communication between PM and SM is restricted to two operations. A retrieval cue (probe) is sent from PM to all traces in SM, and PM can receive a reply (echo) from SM. Each trace in SM is activated according to its similarity with the probe, so traces sharing many properties with the probe are strongly activated, whereas traces sharing few properties are activated by a much smaller amount. The returning echo has two elements; intensity and content. The intensity depends on the total amount of SM activation that was triggered by the probe. If many traces are sufficiently similar to the probe then the intensity of the echo will be high. Echo intensity can therefore be thought of as a signal of familiarity. Echo content reflects the summed contributions of all the traces in SM, as each trace responds according to its similarity with the probe. So, depending on the nature of the probe, the number of strongly activated traces may be large or small, and depending on how closely matched each trace is to the probe, the echo content may be clear or misleading. Via this mechanism various pieces of abstract information may be retrieved form a single memory system storing only episodic traces (see figure 1.2).

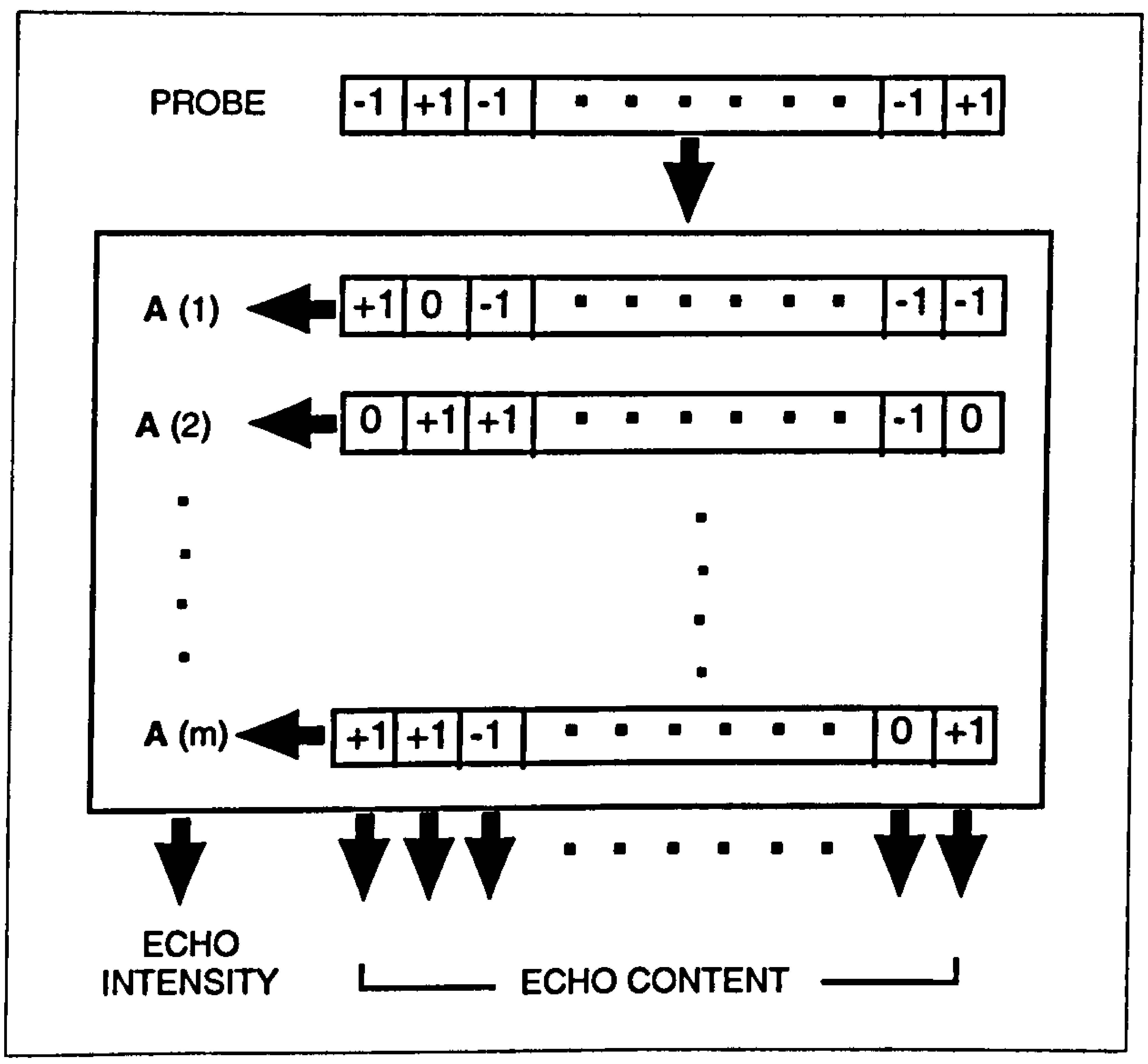



Figure 1.2. From Hintzman (1986). *Trace Activation:* Each trace is activated according to its similarity to the probe. Feature values [$j$ = 1...$n$] are listed from left to right, and traces [$i$ = 1...$m$] from top to bottom. $A(i)$, the activation level of the trace $i$, depends on the proportion of the features it shares with the probe. Echo intensity is the sum of the $A(i)$ values. *Retrieval of Echo Content:* Activation is initiated by the probe and passed down to all features of each trace, as the product of $A(i)$ and the feature value. For each feature, $j$, the products are summed over traces to yield C($j$). Echo content is the set of C($j$) values.

Logan (1988, 2002) proposed a different version of how an instance account might operate, embedded within his general theory of automaticity. He suggests that there are two ways in which an action can be executed. An algorithm may be applied to the problem, or the answer may simply be retrieved from memory. The algorithm method is used for actions that are new or unfamiliar, but each time an action is performed a memory for it is created. This memory may be used the next time the action is required. So the next time the action is necessary, the action may be performed by either performing the algorithm or by retrieving a memory of previously performing the actions. Whether an algorithm or a memory is used depends on which is faster. Logan uses a horse race metaphor to explain the selection of the algorithm or memory retrieval. Performing the action will lead to storing more instances of the action in memory. As more instances are stored in memory, it becomes, statistically, more likely that one of them will win the race with the algorithm.

A less strong view of the instance account is taken by theorists that propose that skill transfer, which relies on the similarity of the underlying processes at study and test, is the foundation of observed priming effects. Support for this position comes from various features of long-term priming. First, these priming effects can last over hours or days (Jacoby, 1983a; Jacoby & Dallas, 1981), whereas theories that account for priming on the basis of temporary activation of existing knowledge typically assume that priming dissipates quickly (though see, Burton, 1990, for a simple mechanism of long term repetition priming). Second, long-term priming is sensitive to the effect of perceptual overlap between study and test operations. In particular, changes in modality or study tasks often reduce or eliminate priming effects (Jacoby, 1983b; Roediger & Blaxton, 1987; Weldon, 1991), suggesting that priming is primarily mediated by the similarity of the processing episodes rather than by modification to abstract representations.

*Evaluating the evidence*

There has been considerable debate in the literature regarding which type of theory can best account for the wide range of priming effects that have been reported in the word, object and face (person) recognition studies. For conflicting reviews of a substantial literature in the lexical field see, Tenpenny (1995), who favours an episodic interpretation, and Bowers (2000) who strongly supports the idea of abstract encoding.

Central to Tenpenny's argument in support of an instance-based account is that many words are processed between the study and test phase of a typical long-term priming experiment. She argues that these intervening words should eliminate the priming, due to the interference that results from lexical competition. However, Bowers (2000) argues that rejecting abstractionist theories, on the basis of the longevity of long term priming, is unwarranted. First, the sheer number of words read in the intervening period does not, in itself, preclude subsequent priming. Kirsner and Speelman (1996) showed that a low frequency word, with a frequency count of one per million would be encountered only once in forty days (assuming the average person reads about 25,000 words per day). Therefore, it would be unlikely that a low a frequency word would be encountered (i.e., primed) immediately before an experiment. So there is no reason to suppose that such a word would not benefit within the experimental setting. This interpretation is consistent with finding that the size of the priming effect for high frequency words is smaller than that for low frequency words, and is occasionally completely absent (Bowers, 1999; Rajaram & Roediger, 1993).

Tenpenny (1995) further argues that abstractionist models cannot account for the different patterns of effects observed for short-term and long-term repetition priming. However, she ignores the possibility that short-term repetition priming may in fact be semantic priming in all but name. All items (words, object and faces) are more closely related to themselves than are close associates of that item. Calder and Young (1996) termed this effect self-priming and proposed that it had exactly the same locus as short-term repetition priming. In fact, they suggest that they are one and the same thing. By this reasoning, short-term and long-term priming effects are mediated by different mechanisms, and dissociations between them should come as no surprise.

There is another, more fundamental argument for prefering the abstractionist view over instance type theories. An advantage of abstract localised representations is that they support compositional representations (Fodor & Pylyshyn, 1988). In contrast, it is unclear how combinatorial systems can be supported in an instance model of memory. There may be some way that the virtual abstract codes (echoes in Hintzman's conceptualisation) could be used as the building blocks for a system (say, language) that constructs complex representations from simpler parts, but to my knowledge, no instance theorists have suggested how this might be achieved.

However, it is possible to imagine that an instance based account could, in fact, produce the type of stored abstract representations that are generally denied by theorists working in this area. A general proposition in this type of theorising is that abstraction takes place at retrieval rather than at encoding. If this is so, then a memory trace coding the abstraction is set up (coding echo content in Hintzman's model). This echo must also be stored as a new trace. Several such traces would code (potentially) a sort of super-abstraction. When activated by the appropriate probe this super-abstraction would be manifest in the echo content and would itself form a new trace. It is difficult to see how this process should not be regarded as coding abstractions. In fact, admitting there may be both episodic and abstract memory traces may provide an explanation for some of the apparently contradictory data in this field. Such a proposal, is made by Nadel and Moscovitch (1997).

*Hybrid Account*

The multiple trace model proposed by Nadel and Moscovitch (1997) differs from that proposed by Hintzman (1986) and others (e.g., Logan, 1988) in that it admits separate episodic and semantic systems. In their model the creation of multiple traces facilitate the extraction of 'factual' information from an episode and its integration with pre-existing semantic memory stores. Facts about the world (e.g., Ben Nevis is in Scotland, oranges are round, etc.) acquired in the context of a specific episode are separated from the episode and are eventually stored independently of it. In essence, this theory proposes that processing proceeds according to the following stages. Each new episode is sparsely coded in an ensemble of hippocampal complex neurons (Marr, 1969; Treves & Rolls, 1994) and is bound into a coherent memory trace (Moscovitch, 1995) which includes the feature information. Each time this memory trace is re-activated, it happens in a slightly different experiential and neuronal context. This re-activation results in the creation of a newly encoded trace, which is again sparse and distributed. By virtue of activating a similar set of neurons this new trace shares some or all of the information about the initial episode. This creation of multiple related traces is said to facilitate the extraction of 'factual' information from the episode, which is then integrated with pre-existing semantic knowledge as described above.

At the present time, it seems that researchers who favour an instance-based approach are able to account for some, but not all of the data, contained within these diverse literatures. The same could be said of those who favour a structural approach. This echoes many of the historical debates in psychology (e.g., nature vs nurture in child development, early vs late selection in visual attention). Ultimately both of these debates were resolved somewhere in the middle. An approach that admits both an abstractionist and instance-based approach may now be warranted. There is good reason to suppose that both types of system exist (there is certainly evidence in favour of both positions). Logan (1988, 2002) has proposed that a race occurs between computational and memory processes when an answer to a particular question is sought. Perhaps this race has more than two runners. Depending on task demands, the answer to a particular question may drop out of the structure of a particular processing system, it may result due to the retrieval of episodic traces, or it may be computed (in whole or in part) from the output of one or both such systems.

Whatever the resolution of this debate turns out to be, it is difficult to conceive of a structured semantic system that is not somehow based on abstracted representations. The experiments which follow will be based on the assumption that abstracted representations form the basis of this system.

## Modularity or Expertise

The question addressed here is whether person recognition is carried out by cognitive systems that are functionally separate from those processes that are used for objects. An important point here is that familiar people (whether recognised from their face or voice or other modality) can only be placed into superordinate categories (i.e., occupation, nationality, etc.) following access to stored semantic information specifically relating to them. This implies that they must be identified at the exemplar level before categorisation can take place. There may some exceptions to this rule, in respect of a small number of familiar people who are highly specified by their visual appearance (i.e., super-model, rock star, etc.), but in general it is impossible to classify people in this way using only perceptually derived information. Objects, on the other hand, can be easily classified (and usually are) using only perceptually derived information at the basic or subordinate levels. Exemplar level identification (crucial to the classification of familiar people) does not usually occur, and is in fact unnecessary for most object categorisation. An important difference, therefore, between person and object categorisation is that person categorisation requires access to personal (exemplar level) stored semantic information, whereas object categorisation may proceed based only on perceptual type codes.

*Modularity*

The modularity/expertise debate, as it relates to person recognition, has recently been addressed in the specific area of face recognition. Our within-category discrimination ability relating to faces is unsurpassed by any other abilities we may have relating to other complex objects. So much so that it has been suggested that face recognition is achieved by a specialised processing system, organised around different principles than those used for other stimuli (Farah, 1990; Tanaka & Farah, 1993). There is a growing body of evidence in favour of this hypothesis. For example, prosopagnosia, the impairment of face recognition after brain damage, can leave object recognition relatively intact (Farah, Levinson, & Klien, 1995). On the other hand, some object agnosics have relatively spared face recognition (Moscovitch, Winocur, & Behrmann, 1997). This double dissociation between face and object processing suggests that the two abilities are functionally distinct, in that one process may occur without the other. Further, it suggests that these processes are carried out in distinct anatomically regions of the brain, as brain damage can selectively impair either ability. Converging evidence comes from both PET and fMRI, which have found distinct areas of activation during face and object recognition (De Renzi, 1997; Sergent, Ohta, & Macdonald, 1992).

A compelling piece of evidence, suggesting how this localisation comes about, is reported by Farah, Rabinowitz, Quinn and Liu (2000). They report a case study of 16 year old boy, Adam, who is densely prosopagnosic, but with no discernible deficit in object recognition. On a battery of tests, Adam's performance mimics that of a typical adult prosopagnosic. What made this case special is the fact that Adam's brain damage was sustained at the age of one day. This study provides the strongest evidence to date that the distinction between face and object recognition is somehow specified in the genome and is anatomically localised.

*Expertise Account*

Alternatively, it has been argued that the behavioural effects that have been selectively observed for faces in some studies (Tanaka & Sengco, 1997) can also be found with non-face objects when experts view these objects (Gauthier & Tarr, 1997). These results are at odds with the idea of a specific module for face recognition, because they violate Fodor's criterion of information encapsulation, which is a crucial aspect of any modular system (Fodor, 1983). However, according to this account the functional and anatomical specialisation for faces (at least in adults) may simply reflect experience with these objects. These authors argue that because we acquire a lot of experience for such judgements throughout our lives, we can recognise faces at a more specific level than most other objects. The idea is that most objects are recognised most efficiently at what has been called the basic level of abstraction. For example a dog is more likely to categorised as a dog (basic level) rather than as a spaniel or poodle (subordinate level) (Jolicoeur, Gluck, & Kosslyn, 1984; Rosch, 1978; Tanaka & Taylor, 1991). Objects at different basic levels can be distinguished by the presence of highly diagnostic features (i.e., wings are a distinctive feature of birds). In contrast, objects (including faces) within the same basic level, share many features. Therefore to distinguish between these objects at a subordinate level, one has to rely on other types of information, such as colour, texture, and variations in the configuration of the features (Bruce & Humphreys, 1994; Diamond & Carey, 1986). This position suggests that the basic level at which an object is recognised changes with exposure to that object. Within this framework faces are typically recognised at a very subordinate level (i.e., the exemplar level: Bill Cinton's face or Tony Blair's face). In essence this position states that without expertise, face processing would not be differentiated from the type of object processing that occurs at the basic level.

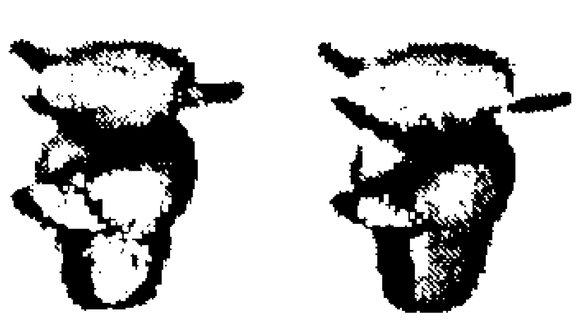
However, an important difference between processing of familiar faces and objects is not captured in this type of framework. Familiar face categorisation is usually conducted at the exemplar level whereas object recognition is usually conducted at the basic or subordinate levels. That is, a robin is classified as a bird or robin and not as a particular robin, whereas a familiar person (say, Tony Blair) is usually classified as a particular person (Tony Blair) and not as a politician or as a person. Therefore, the processing of objects in general should be compared only with unfamiliar faces. Alternatively, a legitimate comparison could be made between familiar faces and personally known objects (your own car, wallet, dog, etc.), as it could then be argued that both categorisations occur at the exemplar level. To my knowledge, such experiments have not been carried out. The main point is that we should not directly compare processing that is assumed to occur at different levels.

However, Gauthier, Anderson, Tarr, Skudlarski, and Gore (1997) claim that subordinate-level matching of objects (as compared to basic level matching of identical stimuli) engages the fusiform and inferior temporal gyri in a pattern that resembles the activation that occurs in the so called 'fusiform face area' (FFA) when a face is processed. These authors suggest that activation the FFA is related to subordinate level categorisation and not face processing per se. Such accounts suggest that faces and other objects may be processed by the same mechanism and is dependent on the level of expertise one has with a particular class of stimuli.

*Evaluation*

The debate between those who favour 'face-specific' processing versus those who favour an explanation based on expertise is by no means settled. Evidence for both positions is largely derived from brain imaging techniques, and both sets of researchers appeal to the idea that certain types of processing activate certain brain regions. The underlying assumption here is that if two processes are anatomically distinct, then by implication they must be also be functionally distinct. On the surface, this is an entirely reasonable method to distinguish separate processing mechanisms. However, one problem is that both sets of researchers use different techniques to identify the area under investigation (the FFA). Kanwisher and Moscovitch (2000) point out that the region identified by Gauthier et al. (2000), is partially or completely non-overlapping with the FFA, as originally defined by Kanwisher (1997). So there appears to be disagreement between these research groups on the anatomical location of the area specialised for face processing. This issue comes into focus if we consider Gauthier's and colleagues work with greebles (Gauthier et al., 1997). These authors argue that through extensive training with greebles, specialised mechanisms can be acquired that resemble and may even overlap with those used to recognise faces. Kanwisher (2000) disputes this conclusion, again based on the fact that it is not clear whether the brain regions responsive to greebles are the same as those claimed for faces. It may be that face processing and subordinate-level processing, engage mutually exclusive areas within this general region, in different individuals, but that these regions average to the same area across a group of individuals. Further, even if it were established that greeble processing and face processing do activate the same distinct area, this does not permit the strong argument that face processing is expertise driven. A more parsimonious explanation may be that an area established for face processing is recruited for the processing of 'face like' stimuli (see Figure 1.3, for example of a greeble). Evidence that other types of expert, within category, discriminations are carried out in the same brain region as face judgements (the fusiform face area) is not evidence against a face module. It may simply be that this area, specialised for one type of within-category discrimination (i.e., faces) is recruited when necessary for other within-category discriminations.

Figure 1.3. Examples of greebles
From Tarr & Gauthier (2000)



A direct comparison between face and object processing was carried by Barry, Johnston and Scanlan (1998). Using a semantic priming technique, recognition and naming latencies were measured for three classes of stimuli; familiar faces, structurally similar objects (living things), and structurally distinct objects (artifacts), across four prime type conditions (associated, same-category, neutral and unrelated). A remarkably similar pattern of results was obtained for both recognition and naming. For faces there was large priming effect in the associated prime condition but none in the same-category prime condition. However, for objects a priming effect was observed in both the associated prime and same-category prime conditions. These differential effects indicate that object and face processing may be subserved by different functional mechanisms. These authors interpreted these results within a model which proposes that semantic knowledge is organised differently for people and objects. The proposal is that the semantic representations of objects are organised around shared features and abstracted superordinate categories. For people the suggestion is that these representations are structured by networks of interpersonal relatedness, rather than by shared features or abstracted categories. This proposal accounts for the observed priming effects for both associative and categorial prime types for objects, and more importantly offers and explanation for the associative but not categorial priming for people.

However, a possible difficulty with this experiment relates to the point that was made at the start of this section. That is, it compares familiar face processing (at the exemplar level) with object processing at the subordinate or basic level. Clearly more experimental work comparing both person and object processing at the same level of categorisation is necessary if we are to fully understand these mechanisms.

## Models of Person Recognition

Until the 1980s, research in face recognition tended to focus on forensic issues relating to unfamiliar people (e.g., Ellis, 1975). This was primarily motivated by the unreliability of eyewitness identification (Yarmey, 1979) despite the weight which juries attached to such reports. A shift occurred with the publication of a study by Bruce (1979) when it became clear that the identification of familiar faces and the discrimination of unfamiliar faces involved different functional mechanisms.

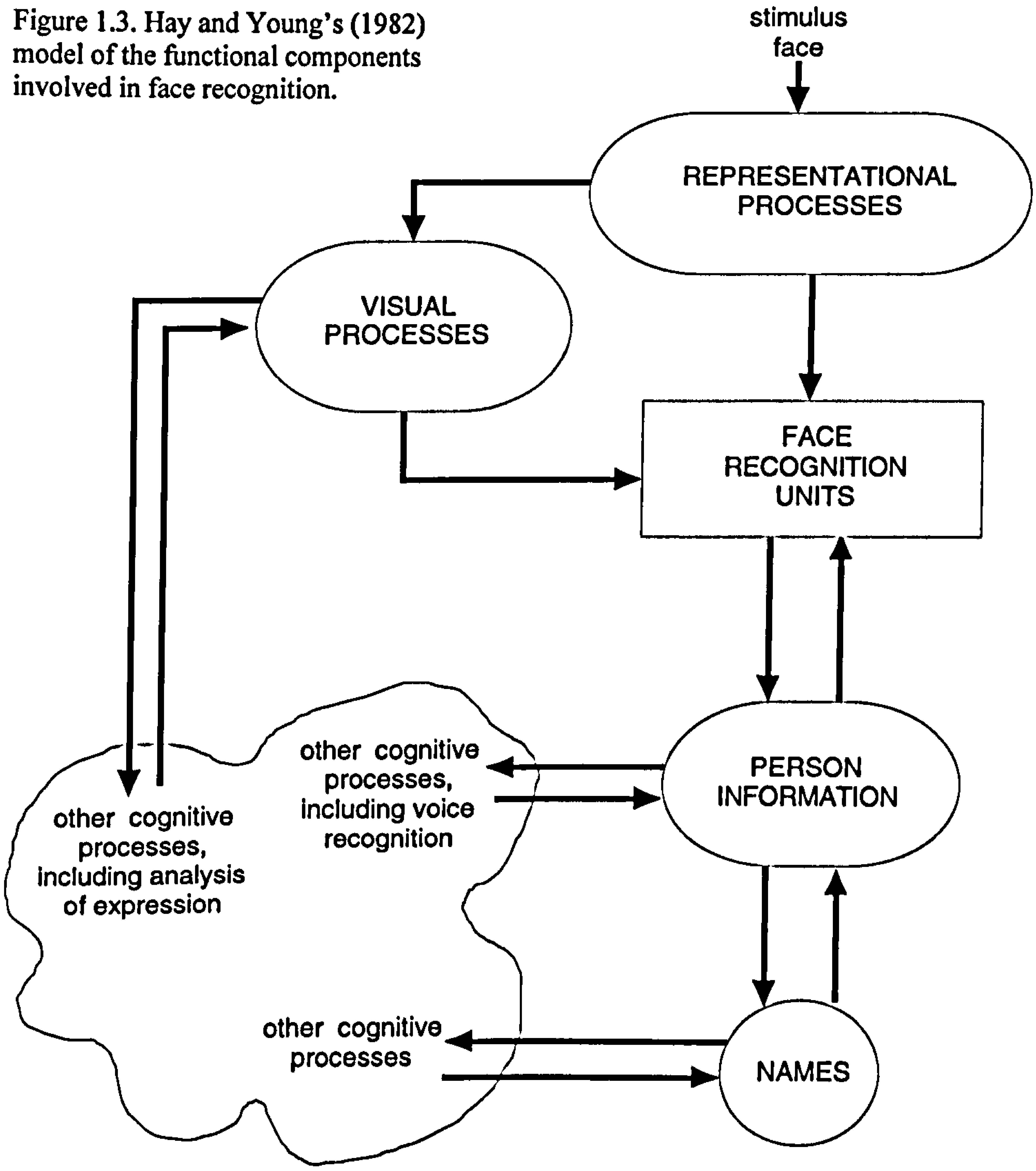
In the Bruce (1979) study participants were asked to determine whether or not faces belonged to British prime ministers. The distractor faces were either visually similar or semantically related (i.e., another politician) to the targets. The results showed that RTs to reject the distractors were slower in comparison to unrelated faces. The effects of visual similarity and semantic similarity were found to be independent, suggesting that visual and semantic analysis can proceed in parallel. This idea was supported by Benton (1980) who conducted a review of the neuropsychological literature and reached the conclusion that different cerebral mechanisms were implicated for familiar and unfamiliar face processing.

The models of person recognition, that are now considered, grew out of earlier models of word recognition in particular Morton's (1979) logogen model. As such they are embedded in the abstractionist tradition discussed earlier. These are functional models, which attempt to explain the processing stages involve in recognising and retrieving information about people.

*Early Models*

Hay and Young (1982) published the first theoretical framework which attempted to explain the processing stages involved in recognition of familiar faces

Figure 1.3. Hay and Young's (1982) model of the functional components involved in face recognition.



(see Figure 1.3). This model made explicit the idea that face recognition may be signalled by "face recognition units" (FRUs), which were roughly analogous to the lexical units proposed in the word recognition literature (e.g., Morton, 1969, 1979). The functional separation of visual and semantic processes in this model provides an explanation for the Bruce (1979) data, which had first suggested the parallel route hypothesis. The separate routes proposed in this model allow the independence of visual and semantic similarity effects which Bruce observed to be accommodated. It also provides a route for the access of identity-specific semantic information, as opposed visually derived semantic information (this distinction becomes important, in Chapter 5, which looks at sex as an identity-specific semantic decision rather than as a visually derived semantic decision). At the time of its publication, there was little experimental data to support such a model, the data from Bruce (1979) being the primary source. However, the model did make several predictions which were later supported. In particular, it suggested that the following malfunctions should occur. First, it suggested that should a face fail sufficiently to activate an appropriate FRU, then familiarity would not be signalled. Failure to recognise a colleague, when we meet them out of their normal context, would be an example of this type of failure. Also, this is exactly the type of failure experienced by prosopagnosic patients who report that all faces appear unfamiliar to them. Second, it suggests that if the route between the FRU and 'personal information' is blocked, an FRU may signal familiarity, but that access to personal semantic information about the face may not be available. Essentially one would have a strong feeling that the face is familiar without knowing anything else about it. Subjectively this appears to happen fairly frequently. Finally, a blockage between 'personal information' and 'names' would predict that the face may be recognised, semantic information accessed, but that name retrieval should fail. This situation will be very familiar to most people and is, in fact, easy to induce (Yarmey, 1973). Importantly, this model also specified situations that should never arise. According to this framework, it should be impossible correctly to name a face in the absence of semantic information relating to it.

Young, Hay and Ellis (1985) provided evidence, in the form of a large scale diary study, which offered support for the Hay and Young framework. These authors asked participants to keep formal records of any difficulties they experienced when recognising people during the course of their everyday activity. There were 922 reported errors or difficulties recorded by 22 participants over a seven week period. None of these involved an inability to recall semantic information when the name was available. However, all participants reported failures of the type suggested by the Hay and Young model, in fact, over 90% of all errors reported fell into one of the three main categories described above.

Young, McWeeny, Hay and Ellis (1986) reported further data consistent with a sequence of processing stages in which semantic codes are processed subsequent to structural codes but prior to name retrieval. In essence, this study showed that familiarity decisions (is this face familiar?) are faster than semantic decisions (is this a politician?). Importantly, these authors also demonstrated that semantic decisions were easier to make when all familiar faces were drawn from the same semantic category, but that the use of consistent or mixed categories did not effect RTs for familiarity decisions. It was argued that this experimental manipulation does not effect the speed of the familiarity decision because such a decision can be taken at the level of the FRUs, which is upstream of any semantic processing.

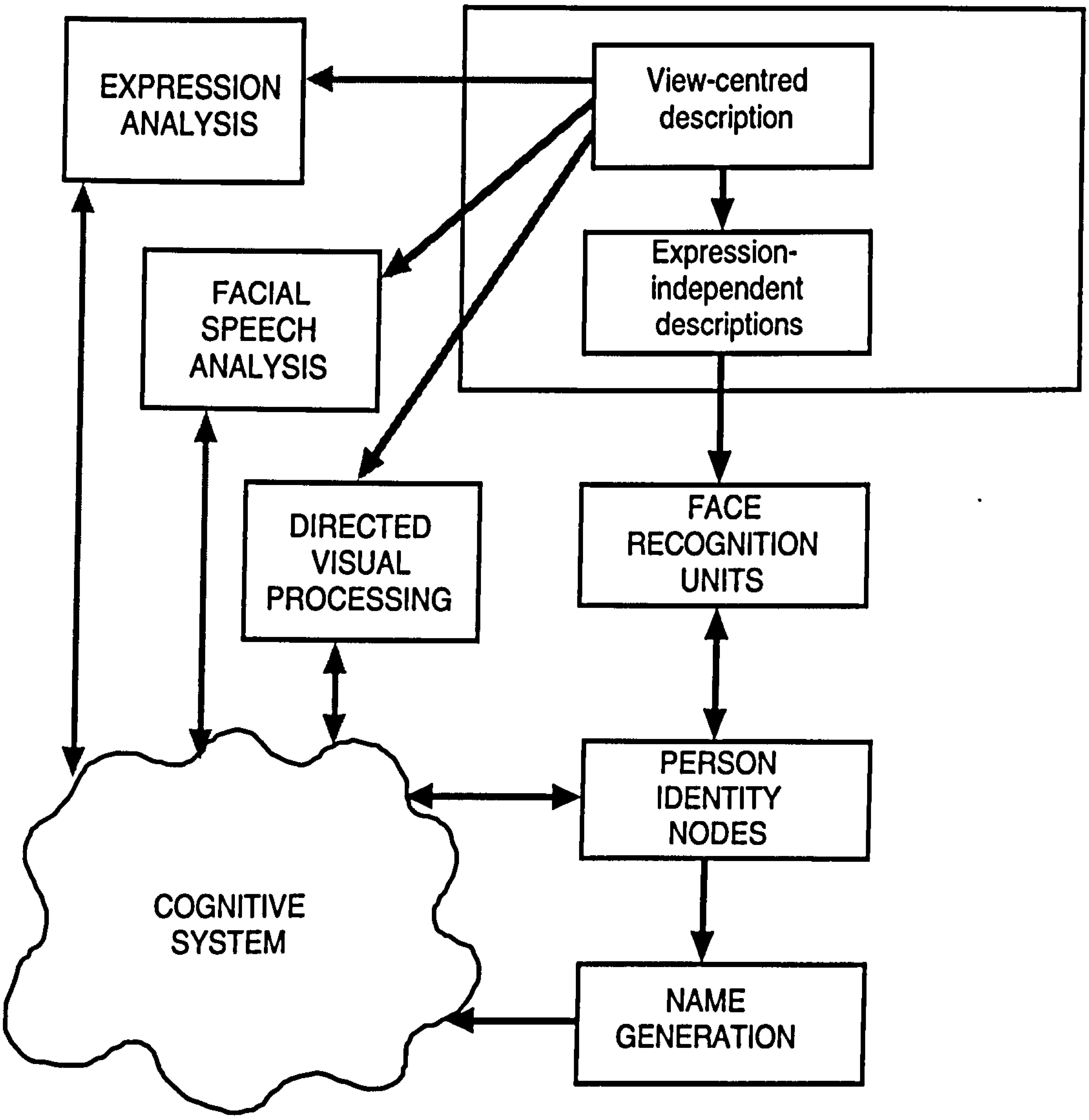
Hay and Young's suggestion that FRUs might function in a similar way to logogens in models of word recognition (Morton, 1969; Warren & Morton, 1982) was investigated by Bruce and Valentine (1985) using the face familiarity decision task developed by Bruce (1983). Thresholds, in logogen models, can be lowered directly following presentation of the item itself (identity or repetition priming), or indirectly via the semantic system, following presentation of a semantically related item (semantic or associative priming). The face familiarity task makes demands that are roughly equivalent to the lexical decision task used in word recognition studies. This task involves presenting participants with a series of familiar faces intermixed with unfamiliar faces. The participant's task is to decide as quickly as possible whether or not the face is familiar. Bruce and Valentine (1986) found that RTs for familiar faces were faster if that same person's face had been presented previously (in either the same or different views). No facilitation was observed when the earlier exposure was the name of the same person. This implies that the locus of this repetition priming effect must be at a stage earlier than that which names are accessed. As names and faces access the same personal information in this model, the locus of this effect must be upstream of this module. Bruce and Valentine suggested that the FRUs as the obvious possibility.

Additional support for this type of theorising came from experiments involving semantic (or associative) priming. Bruce (1983) showed that familiarity decisions were faster if a face was immediately preceded by that of a close associate. For example, participants were faster to decide that Lady Diana's face was familiar if it was preceded by the face of Prince Charles, rather than that of, say, Tony Blair. Bruce and Valentine (1986) extended this finding using a more elaborate design. In these experiments, the faces were presented in pairs, with a response only required to the second face. Stimulus onset asynchronies (SOAs) were varied between the prime and target faces, and the effect of a related prime was compared with both an unrelated (but familiar) and an unfamiliar (neutral) primes. The main finding here was that significant facilitation was found for the related prime even at very short SOAs. This is consistent with the idea that these effects are mediated by 'automatic' spreading activation within the semantic system (Neely, 1976; Posner & Snyder, 1975). In terms of the model proposed by Hay and Young (1982) these effects could arise because recognition of the prime face (e.g., Prince Charles) activates personal information relating to him and that this activation spreads to associated personal information, which should include that information relating to Lady Diana. Activation of personal information should then lead to reduced thresholds at Lady Diana's FRU.

These early findings supported the idea that FRUs functioned as threshold devices, as suggested by Hay and Young (1982), but subsequent work revealed problems with this account. The first difficulty is in interpreting the results from a growing number of repetition priming studies. In particular, Ellis et al. (1987) found that similar views of a face gave more priming than dissimilar views. This finding is more consistent with a visual memory rather than a FRU interpretation. More important was the finding that repetition and semantic priming effects did not dissipate in the same way. Bruce (1986) produced data which demonstrated that repetition priming effects showed no sign of decay when intervening faces were presented between prime and target faces. The effect persisted with up to 11 intervening faces, which corresponded to a time lag of about 60 seconds. On the other hand, semantic priming effects were observed only when the prime face immediately preceded the target. Support for these differential effects was provided by Dannebring and Briand (1982), who found exactly the same type of effects using words in a lexical decision task. This finding requires that additional assumptions be made about the functioning of the FRUs. That is, threshold changes produced by direct 'bottom up' activation of an FRU must be distinguished from indirect 'top down' increases in activation from the semantic system.

In 1986, Bruce and Young produced one of the most influential models in the area of person recognition (see Figure 1.4). While this model was more tightly specified, and broader in scope, than that of Hay and Young (1982), its proposals regarding access to semantic information were essentially the same. Processing in the Bruce and Young (1986) model proceeded in the following way. Structural encoding

Figure 1.4.




processes produce a set of descriptions at different levels of abstraction. View centred descriptions provide information for the 'Expression' and 'Facial Speech' modules. However, from the standpoint of this thesis it is the abstract, expression independent, descriptions that are of more interest. These descriptions provide information for the FRUs. As in the Hay and Young model, each FRU contains stored structural codes describing a known face. At this point, Bruce and Young differ from Hay and Young and propose that a graded signal, at a level dependent on degree of resemblance between the structural encoding the stored description, is passed from the FRU to the cognitive system. It was suggested that this graded signal was used to determine the familiarity of the face. However, no mechanism was specified for translating this signal into an explicit decision regarding whether or not the face actually belonged to a known person or simply looked like one. It was proposed that these FRUs had access to identity-specific semantic codes held in a portion of associative memory, which these authors labelled person identity nodes (PINs). These PINs were seen as the entry point to the more general associative memory system.

It was further suggested that the basic level of activation of the FRU can be 'primed', either directly, because that face has recently been seen (repetition priming), or indirectly via activation flowing back from the PINs to the FRUs (semantic priming), because an associated person has just been seen. The problem with this account is that it fails to describe the different nature of repetition and semantic priming effects. As previously discussed, the time course of these effects are different. Repetition priming is robust over a 20 minute period (at least), and survives several intervening items between the study and test phases of these experiments.

Semantic priming, on the other hand, is abolished by only one intervening item, Bruce (1986). Another difference is that semantic priming crosses stimulus domains (Young, Hellawell, & deHaan, 1988), whereas repetition priming is domain specific (faces do not prime names and vice versa). The differing nature of these effects suggests that they have different loci within the system. The clear difficulty for the Bruce and Young model is that the locus of both effects is activation at the level of the FRUs. This node may become active for different reasons but there is no mechanism to describe how it became active. The model therefore does not distinguish between these effects.

So while undoubtedly more tightly specified and greater in scope than the previous model, this model, like its predecessor, fails to provide a sufficiently detailed explanation regarding the differences observed between repetition and semantic priming effects. These differences were taken to indicate that the sources of facilitation arose at different loci within the recognition system in each case (Bruce, 1986; Young et al., 1988), but more precise specification of the underlying mechanisms, within the Bruce and Young framework, proved difficult. A further problem for this model was the finding that a densely prosopagnosic patient (P.H.) demonstrated preserved semantic priming (deHaan, Young, & Newcombe, 1991;

Young et al., 1988). Using an explicit recognition test, this patient failed to recognise any of a set of 40 famous faces that were shown to him. This even extended to tests that might be regarded as implicit. For example, he performed at chance when asked to guess which face was famous, using pairs of faces that contained one famous and one non-famous face. However, when tested with the same people's names, he was able to provide correct information for some 90% of the names presented, clearly demonstrating that had not forgotten that he knew the people concerned. By using faces as primes and names as targets, Young et al. (1988) were able to demonstrate that this patient showed the normal pattern of semantic priming. Further, they showed the same pattern irrespective of whether faces or names were used at the study phase.

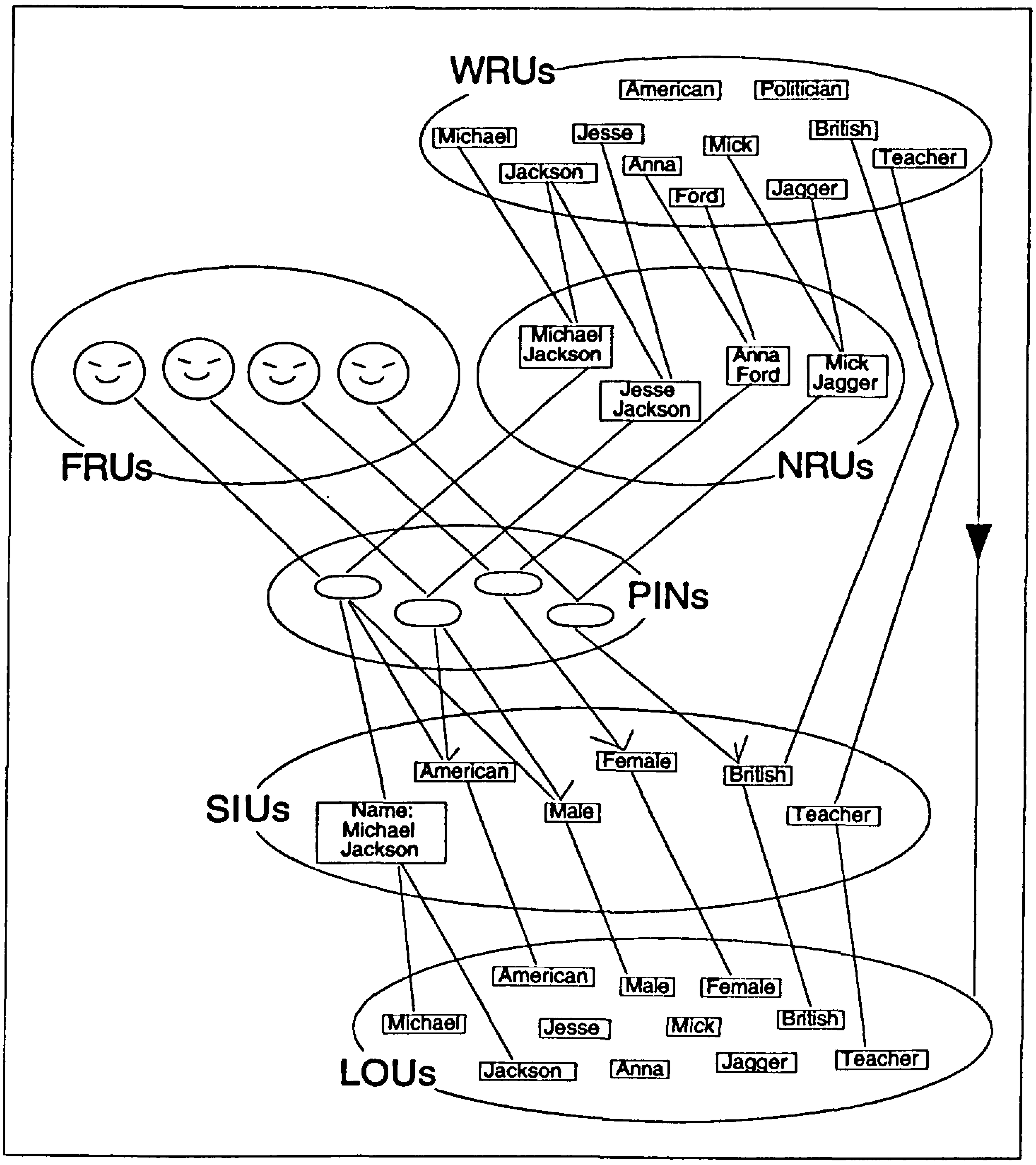
Taken together, the effects of repetition priming, semantic priming and covert recognition in prosopagnosia, were difficult to accommodate within the Bruce and Young framework. In order to accommodate such effects are more detailed model was necessary.

*IAC Models*

Using a localist connectionist procedure, similar to that described by McCelland and Rumelhart (1981), Burton Bruce and Johnston ( 1990), produced an implemented model of the person identification route in Bruce and Young's model. This model must be regarded as a model of *familiar* person recognition and has nothing to say regarding processing that can be undertaken on unfamiliar faces (e.g., expression analysis, facial speech analysis). This model is important because it is sufficiently detailed to provide an account of the repetition and semantic priming effects, as well as those effects observed in covert recognition in prosopagnosia.

Figure 1.5 shows a recent version of this model (Burton & Bruce, 1992). It is a simple interactive activation and competition (IAC) network based on the architecture described by McClelland (1981). It is made up of simple processing units clustered into pools. Within each pool the units are mutually connected with inhibitory links. The links between pairs of units in separate pools are excitatory and all links are bi-directional. There are four pools of units in the central architecture. Face recognition units (FRUs) are intended to code known individuals' faces. There is one unit per known face, and these become active on presentation of any recognisable view of the face. The name recognition units (NRUs) code the names of known individuals and operate in analogous fashion to the FRUs. The person identity nodes (PINs) represent the level of a person, not tied to the mode of recognition, and different recognition routes converge here. This is a key feature of the model. By explicitly separating the

Figure 1.5




PINs from semantic information, it is possible to access the PINs and hence achieve a sense of familiarity, without accessing semantic information. Finally, there is a pool of semantic information units (SIUs) representing individual semantic propositions.

In developing this model, Burton et al. (1990) proposed that familiarity decisions are taken at the PIN level. A common activation threshold is set for all units within the pool and familiarity is signalled if any unit passes this threshold. A similar mechanism operates at the level of the SIUs in order to signal semantic decisions.

Repetition priming on to familiarity decisions is captured in the model by appealing to Hebb-like link strengthening between between FRUs or NRUs and their respective PINs (Burton et al., 1990). This priming does not cross domains, because the strengthening of the FRU-PIN link (which occurs on presentation of face) gives no subsequent advantage for recognition through the NRU-PIN link on presentation of a name (or vice versa). Recently, however, repetition priming has been observed across domains on to *semantic decisions* because, in addition to the FRU or NRU and PIN links, the PIN-SIU links are also strengthened (Burton, Kelly, & Bruce, 1998, experiment 2). Irrespective of the stimulus domain, priming should occur if a shared link has been previously strengthened, by an appropriate name or face, during the priming phase. As a consequence of the global architecture of this model, all PIN-SIU links are strengthened, so this priming will persist even when different semantic decisions are required at study and test (Burton et al., 1998, experiment 3).

Reading names or producing a name in response to a definition also primes subsequent naming of faces. This priming across stimulus domains takes advantage of link strengthening between PINs and SIUs and also between the SIUs and LOUs (lexical output units) (Ellis, Flude, Young, & Burton, 1996).

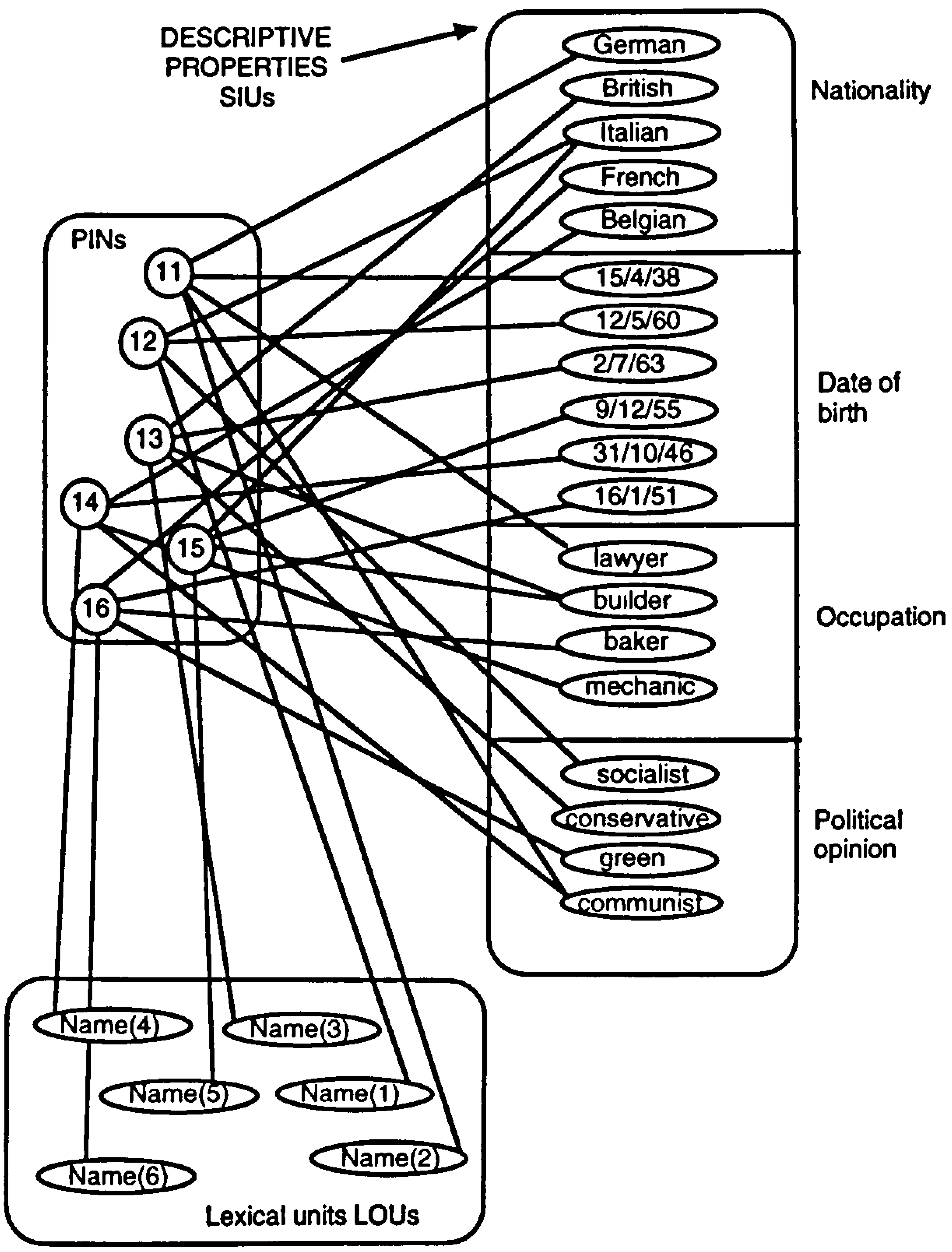
The mechanism to account for semantic priming involves the interaction of PINs and SIUs. When a particular PIN is activated, either by it's associated FRU or NRU, activation from the PIN flows to the SIUs that are connected to it. Some activation flows back from these SIUs to PINs that share semantic features with the original person, taking activation in any such PIN above its resting level. For example, suppose input is given to the FRU of John Lennon. Activation flows to John Lennon's PIN, which in turn activates the SIUs with which he is associated (e.g., Beatle, songwriter, British, etc.). As Paul McCartney's PIN is also connected to many of the same SIUs, activation spreads back to Paul McCartney's PIN taking it above its resting level. The level of this 'above resting activation' depends on how many semantic features are shared. If at this point input is given to Paul McCartney's FRU, activation will flow to his PIN, which will reach threshold faster than had it started at resting level, and this is the basis of the facilitatory effect.

Another strength of this account is that it provides a simple explanation for the phenomena of covert recognition in prosopagnosia. This effect can be simulated by simply by halving the connection strengths between FRUs and PINs (Burton, Young, Bruce, Johnston, & Ellis, 1991).

A development of the Burton et al. implemented model was offered by Brédart et al (1995). The primary purpose was to investigate why person naming always comes after retrieval of semantic information in the processing hierarchy. Burton and Bruce (1992) had previously offered an explanation for this finding in terms of the uniqueness of names. However, Brédart et al. (1995) argue that a side effect of this proposal is the prediction that the more you know about a person the harder it would be to retrieve their name. This follows as a natural consequence of the architecture of the model. Many known facts will activate many SIUs which will in turn inhibit the name SIU of the person concerned.

Brédart et al.'s solution to this problem posed by the relative difficulty of name retrieval was to propose that names are stored separately from other semantic information but accessed in parallel. Their model included one pool of token markers (equivalent to PINs in the Burton et al. model), one pool of names, and several pools of semantic properties such as occupation, nationality or political opinion (see Figure 1.6). This model was able to replicate the interesting properties of the Burton et al. model and also account for the fact that names are more difficult to retrieve than

Figure 1.6




identity-specific semantic information. There must, of course, be links from the SIUs in this model to lexical output units. These links are made explicit in subsequent versions of the model (see Valentine, Brennnen, & Brédart, 1996). This would lead to the prediction that one should be faster to say someone's name rather than their occupation, as there is one less processing stage involved in such a decision, according to this model. This prediction would appear to be inconsistent with the large body of evidence that suggests semantic decisions are made faster than naming decisions. Recent data, demonstrating that naming is slower than making a semantic decision, is also inconsistent with this prediction of the Brédart et al. model (Burton, Jenkins, & McNeill, 2002).

More importantly, the models above provide a starting point to study the organisation of semantic knowledge for familiar people. In the Burton et al. model semantic information is stored in an undifferentiated away. The Brédart et al. model suggest that this knowledge is organised in separate pools such as occupation, nationality, etc. Early experiments in this thesis will test differential predictions derived from these competing accounts.

Before moving to the experimental sections of this thesis, we need briefly to address two further issues. First, there has been considerable debate in the literature about whether semantic priming effects are in fact due to *associative* or *categorial* relationships (Barry, Johnston, & Scanlan, 1998; Brennen & Bruce, 1991; Young, Flude, Hellawell, & Ellis, 1994), and this debate echoes a similar division in the word recognition literature (Lupker, 1984; Shelton & Martin, 1992). Under a categorial account, pairs of items prime each other precisely because of their semantic relationship. So, membership of a common category is itself the mechanism underlying priming because category membership provides a *definitional* relationship between the items. In contrast, associative accounts rely on the fact that related items have common associations. Under the IAC account of semantic priming, described above, pairs of items are related to the extent that their PINs share common SIUs. However there is no inherent structure in these PIN-SIU relationships; links to one SIU do not imply links to other, semantically related propositions. The relationship between people is therefore based on those SIUs with which each has been associatively linked, and which they happen to share in common. A different version of the associative account relies on simple co-occurrence of two items; for example, related people will tend to be seen together. This categorial/associative issue is unresolved empirically, and is currently the focus of much research (e.g., Carson & Burton, 2001). The problem for research attempting to draw the distinction empirically is that many items which are related associatively will also be related in a categorial fashion. Although the experiments in this thesis are not designed explicitly to address this issue, they may have some bearing on it, and we will return to a discussion of the semantic/associative distinction in the final chapter. Throughout this thesis, no distinction will be made between semantic and associative relations, and the terms semantic and associative priming will be used interchangeably.

The second issue for consideration is the much more general theoretical division between *abstractionist* accounts of priming, such as that contained within the IAC model, and *episode-based* theories. Episodic accounts of priming (e.g., Blaxton, 1989; Jacoby, 1983a; Jacoby & Brooks, 1984; Weldon, Roediger, & Challis, 1989) emphasise the retrieval of stored event memories. Retrieval (or re-activation) of information about the priming episode facilitates processing on the second encounter with the stimulus. This type of theory can accommodate much of the repetition priming data. For instance, the fact that face recognition (in a familiarity task) is facilitated by prior presentation of a face but not by prior presentation of a name, is consistent with this type of account. However, experiments in which decision-type is manipulated can sometimes provide patterns of priming which are much harder to accommodate in episodic terms (e.g., Burton et al., 1998; Ellis, Young, & Flude, 1990).

The theoretical debate between structural and episodic accounts of priming is most commonly applied to repetition priming. However, the issue emerges in semantic priming too. For example, Young et al. (1994) demonstrated semantic priming for familiarity decisions but not for sex decisions. This finding suggests that priming is a consequence of changes within the person recognition system and is consistent with structural accounts. An episodic view of priming sits most easily with the position that semantic priming is in fact associative priming, and that facilitation is observed when subjects bring to bear previous episodes of seeing two people together. Although this thesis does not, of course, resolve this issue, some of the experiments below provide some converging evidence for a structural, rather than an episodic view of semantic priming.

## SUMMARY OF PERSON RECOGNITION MODELS

Researchers adopting an information processing approach, based on logogens as proposed in models of word recognition, has led to functional models describing the processing stages in person recognition (Bruce & Young, 1986; Hay & Young, 1982). The analogy between person recognition and word recognition was supported by comparisons of repetition and semantic priming effects (e.g., Bruce, 1986). A hierarchical system was postulated in which structural codes derived from a face (or other input modality) are compared to face (or other modality) recognition units. Identity specific semantic information can then be accessed and finally the person's name can be retrieved. Evidence for such models was derived from diverse literatures including; diary studies (Young et al., 1985), experimental psychology (e.g.,Young, Mcweeny, Ellis et al., 1986; Young, Mcweeny, Hay et al., 1986), and neuropsychology (e.g.,Flude et al., 1989).

These models offer a parsimonious explanation of wide ranging data in the person recognition area and will be used guide the experiments reported in this thesis. However, these models are currently under-specified in terms of how semantic information about familiar people might be structured.

## OUTLINE OF EXPERIMENTAL SECTION

The experimental section of this thesis will seek to find new data exploring the structure of semantic memory for familiar people.

In Chapter 2, semantic priming using a semantic decision is examined. Priming of this particular type is found for the first time. This new semantic priming technique is then combined with an intervening item in order to compare predictions derived from the models of Burton et al. (1990) and Brédart et al. (1995). The first model, (Burton et al., 1990), suggests that semantic is contained in on large undifferentiated pool, the other (Brédart et al., 1995) suggests that such information may be contained in smaller pools which code biographical details such as occupation and nationality. These experiments fail to discriminate between the models.

Chapter 3 pursues the task of discriminating between these models by using a semantic interference technique, but again fails to discriminate between the models.

Chapter 4 takes a step backwards, seeking to determine the true nature of the semantic priming effect observed in Chapter 2, and the locus of this effect is established.

Chapter 5 examines the categorisation of sex (traditionally viewed as visually derived semantic property) as an identity-specific semantic property and reports new data which suggest that sex categorisation can tap similar processes as those involved in other identity-specific classifications.

# CHAPTER TWO

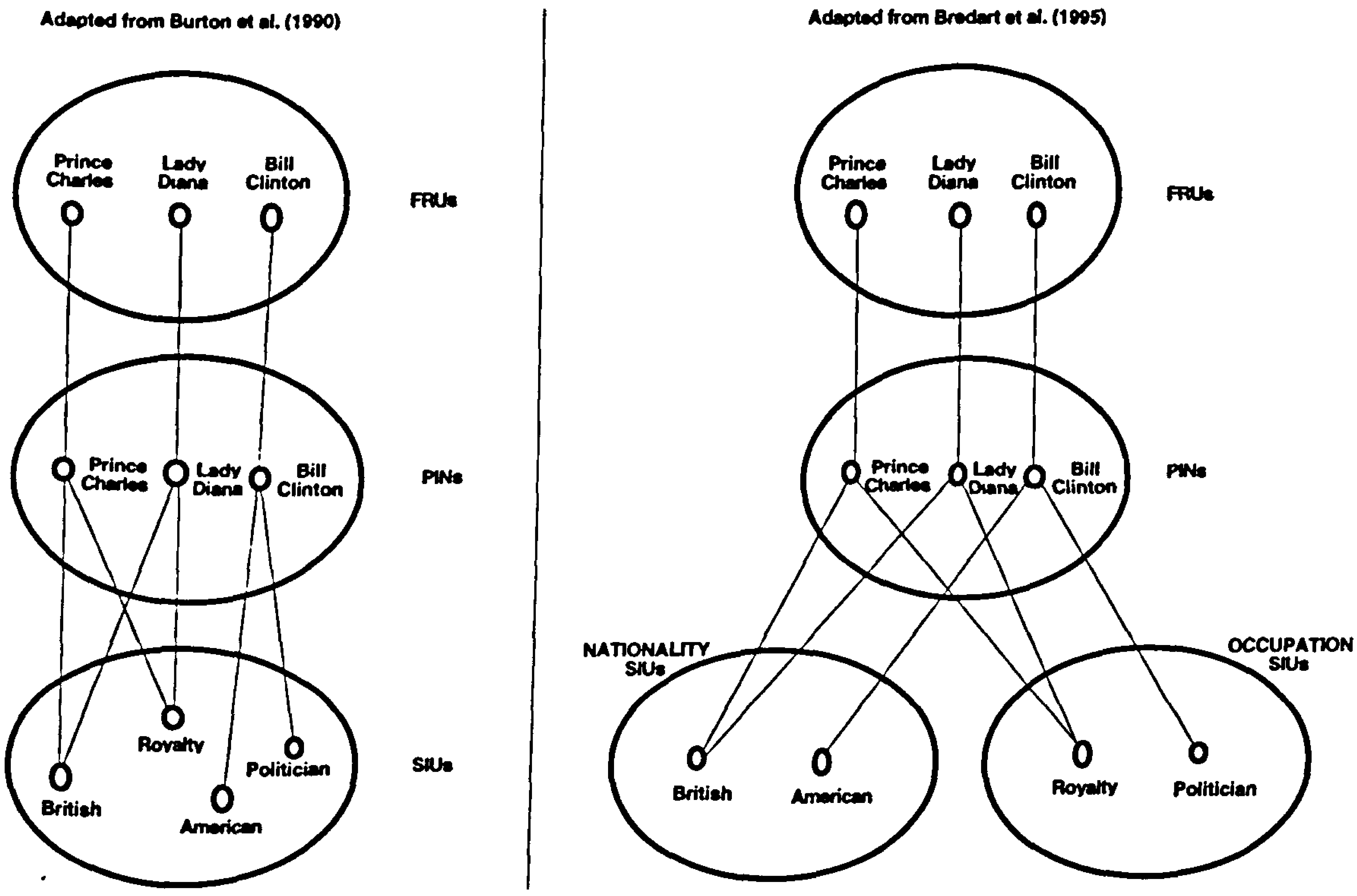
*Exploring Intervening Item Effects*

## OVERVIEW

A major limitation of current IAC models of person recognition is that they do not provide an adequate model of semantic memory for familiar people. The starting point for this chapter is that the current models of memory for personal information are not satisfactory. Broad models have been proposed but these have not been subject to experimental investigation. In this chapter, an attempt will be made to discriminate between two broad categories of explanation.

Two popular contemporary theories about memory for personal information are the models proposed by Burton et al. (1990) and Brédart et al. (1995). Burton and colleagues' model has already been described in detail in Chapter 1. In this model, semantic information is stored in a single undifferentiated pool. Within this pool, all information is connected in inhibitory fashion, and differences in the ease of access to this information is due to the pattern of connections outside the pool, rather than to structure within it. Brédart et al.'s model was also described in Chapter 1 and is similar in many ways. However, one important difference is that, in this model, semantic information is clustered into small pools, each representing the range of possible values for a particular attribute. For example, there is a pool of information representing possible nationalities, another for possible occupations and so forth. Figure 2.1 compares the structure of both models.

Figure 2.1



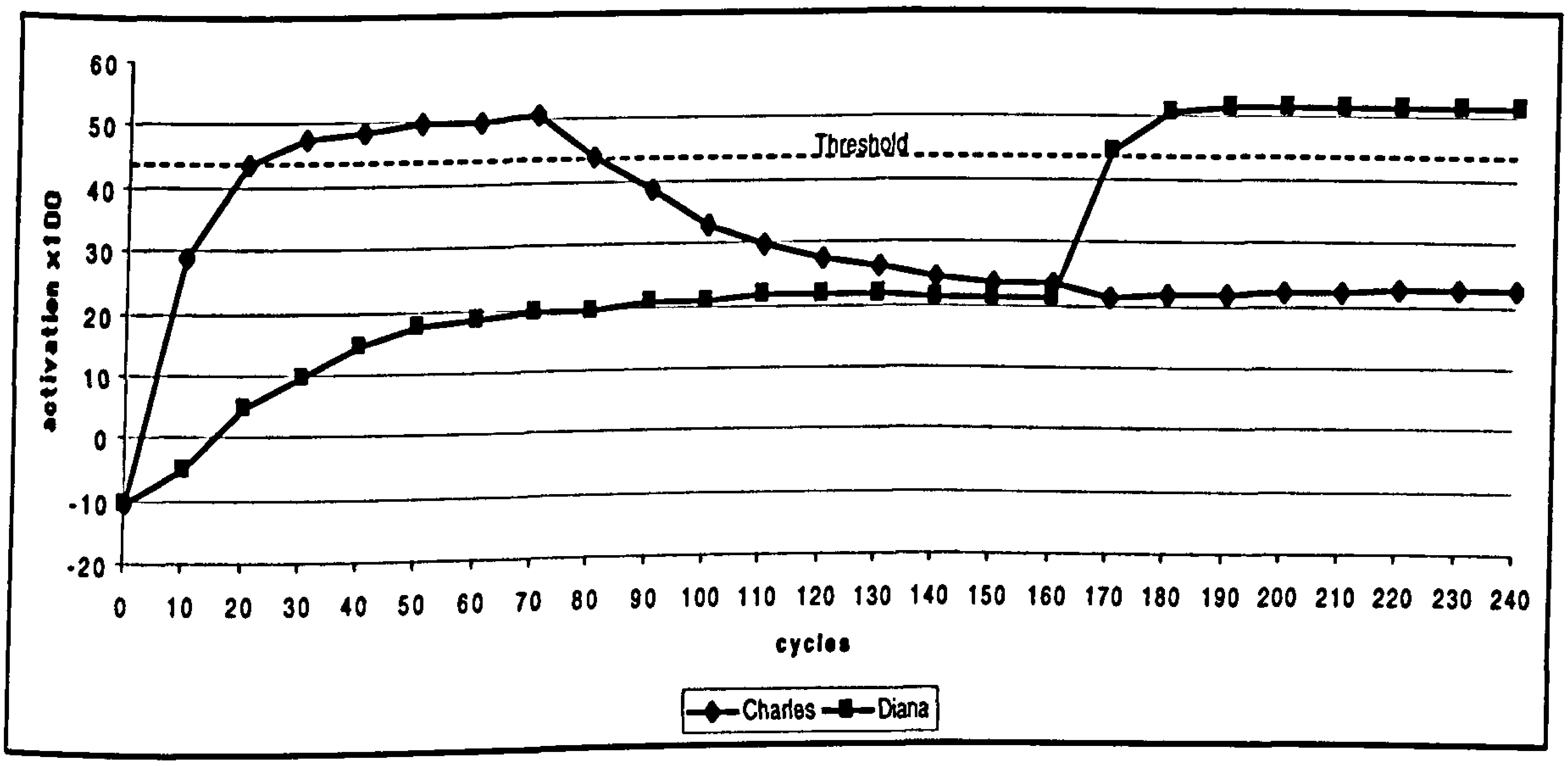

The differing structure of the models regarding the storage of semantic information gives rise to different predictions about patterns of semantic priming which might be expected when semantic information is retrieved. In order to understand why each model makes a different prediction about the pattern of semantic priming effects it is necessary, first of all, to look at how theory in this area has been influenced by the findings from experiments which have examined semantic priming effects.

Semantic priming in the area of person recognition has been fully described in Chapter 1. Therefore, the brief review that follows will focus only those findings that are directly pertinent to the question of differentiating between the above models. In a typical semantic priming experiment, participants are asked to make a judgement about a face (usually a familiar/unfamiliar judgement) as fast as possible. Responses are usually faster to an item if it has been preceded by a related item. So, for example, participants are faster to recognise Eric Morecàmbe if he was preceded by Ernie Wise than if he was preceded by John Lennon (Bruce & Valentine, 1986). It is well known that this effect is short-lived, and can be destroyed by an intervening unrelated item. For example, a fast sequence of Wise-Lennon-Morecambe gives no priming, even though a sequence of Wise-blank-Morecambe lasting the same time, produces priming (Bruce, 1986). Support for the idea that semantic priming is eliminated by an intervening item is provided by (Dannenbring & Briand, 1982) who report similar effects using words.

Explanations of this effect commonly rely on the idea that an intervening item "wipes clean" activation of a concept within a representational pool, and it is this property that will be recruited, in the following experiments, in an attempt to discriminate between the models.

Burton et al. (1990) offers an explanation of the time course of the semantic priming effects described above, within an interactive activation and competition

Figure 2.2 (Adapted from Burton et al., 1990)

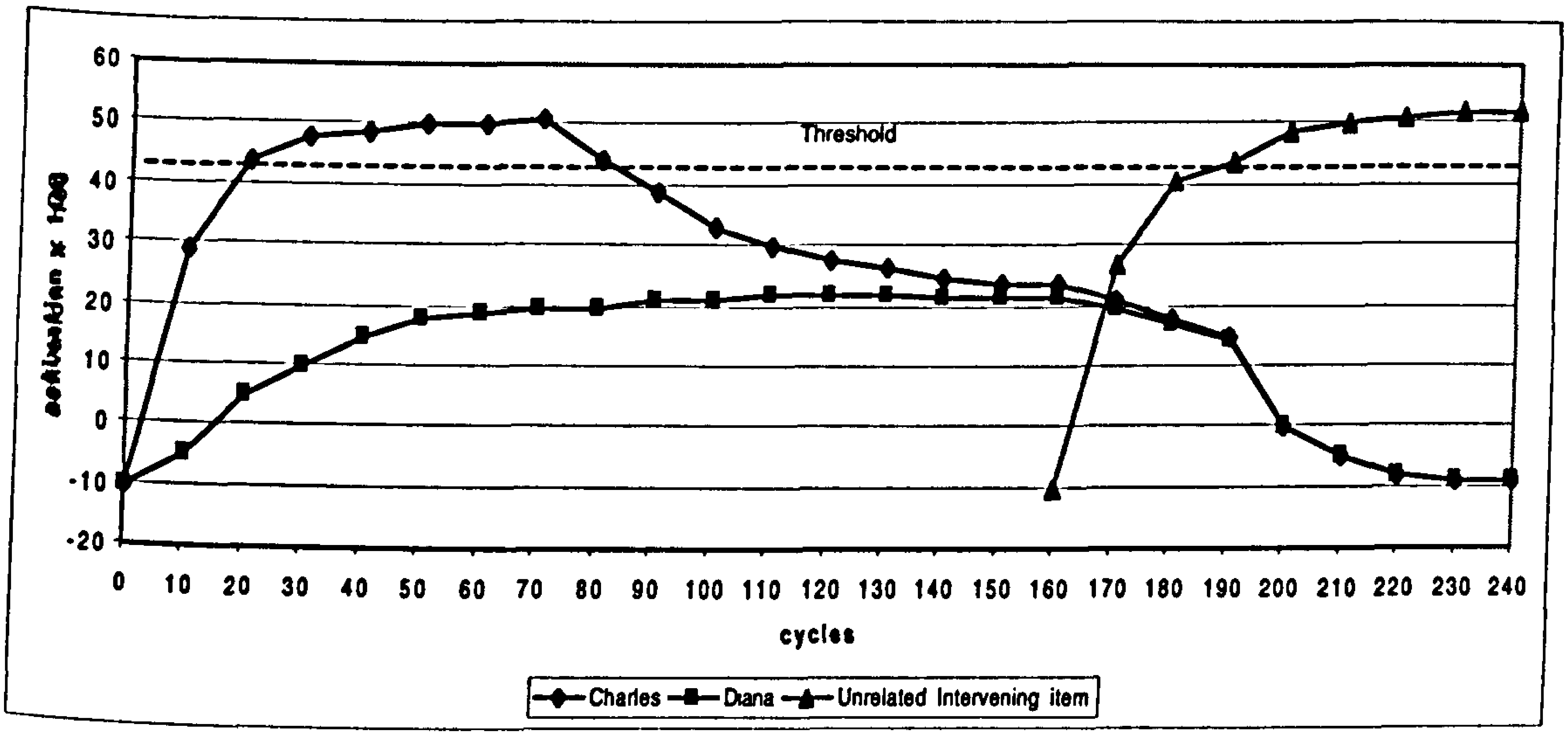



model. Figure 2.2 (adapted from Burton et al., 1990) simulates the activation levels of two PINs during the course of a basic (i.e., no intervening item) semantic priming experiment. These simulations assume that a push button response, in a familiarity decision task, can be made on the basis of the appropriate PIN reaching threshold. The number of cycles necessary for a PIN to reach this threshold may be seen as an estimate of the time necessary to access this person's identity.

In this demonstration, the 'Prince Charles' FRU has been activated, and the 'Prince Charles' PIN consequently becomes active. As this PIN rises, the semantically associated PIN for 'Princess Diana' also rises. Figure 2.1 shows that the 'Prince Charles' PIN reaches threshold quite quickly (after about 25 cycles). The 'Princess Diana' PIN also rises, but stabilises well below threshold. After 80 cycles, activation to the 'Prince Charles' FRU is switched off, and the simulation is run for a further 80 cycles with no external input. This period, devoid of external activation, represents the inter-stimulus-interval period of a behavioural experiment. During this period, the 'Prince Charles' PIN falls quickly below threshold. The 'Princess Diana' PIN, however, decays more slowly. The reason for this is that this PIN continues to receive activation, via semantic units shared with Prince Charles, which initially outweigh the effects of decay. After the 'inter-stimulus-interval' of 80 cycles, activation is applied to the 'Princess Diana' FRU. As the 'Princess Diana' PIN starts with above resting activation, it reaches threshold faster (i.e., in fewer cycles) than did the 'Prince Charles' PIN on the initial presentation There is a large amount of behavioural data which supports this model of semantic priming (e.g., Bruce & Valentine, 1986).

Figure 2.3 (Adapted from Burton et al., 1990), shows how this semantic priming effect is abolished by an intervening item. The first 160 cycles in this

Figure 2.3 (Adapted from Burton et al., 1990)




simulation are exactly as in Figure 2.1: the 'Prince Charles' FRU is activated for 80 cycles, followed by 80 cycles with no activation. At this point, the FRU of an unrelated item is activated. The simulation shows the effect of this unrelated item. Within-pool inhibition, from the unrelated item, drives the 'Lady Diana' PIN down towards its resting level of activation, thus abolishing the advantage that led to the priming effect in the previous demonstration. So, if Diana's face were now presented (by activating her FRU), no advantage would be observed.

In summary, these simulations suggest that above resting levels of activation at a given PIN is the mechanism that accounts for the semantic priming effect, and that this effect is abolished by 'within-pool inhibition' from an intervening item, rather than by the simple passage of time. This simulation supports the behavioural experiments using intervening items reported by Bruce (1986). The key point is that 'within-pool inhibition' is the mechanism that abolishes the priming effect. If an intervening item does indeed abolish semantic priming, via the mechanism of within-pool inhibition, then it should be possible to use this effect to discover how information is clustered into pools.

The above demonstrations simulate the semantic priming effect when a *familiarity* decision is required. Can the same logic be applied to *semantic* decisions? Theoretically, there is no problem with this proposal. Just as there is a common threshold for signalling familiarity decisions within the PIN pool, there is a similar common threshold, within the SIU pool, that signals semantic decisions. Any SIU crossing this threshold signals retrieval of that piece of semantic information (Burton et al., 1998). Both the Burton et al. and the Brédart et al. models appeal to this same mechanism to signal retrieval of semantic information. If a PIN can be 'primed' by an associated item, then it seems reasonable to suppose that an SIU can be 'primed' in a similar fashion. Further, if an SIU can be 'primed' then it should be possible to abolish this priming using an intervening item. Of course, the semantic properties of this intervening item will need to be carefully controlled.

To date, however, there have been no attempts to use semantic decisions in a semantic priming paradigm. Therefore, no experimental evidence is available which might guide predictions using this technique. However, an advantage of both models is that they have been implemented and can be therefore be used to generate explicit predictions. So, in the absence of useful empirical data, the Burton et al. model will be used to simulate semantic priming effects, using decisions at the semantic level. These predictions will be used to guide the experiments presented in the later part of this chapter.

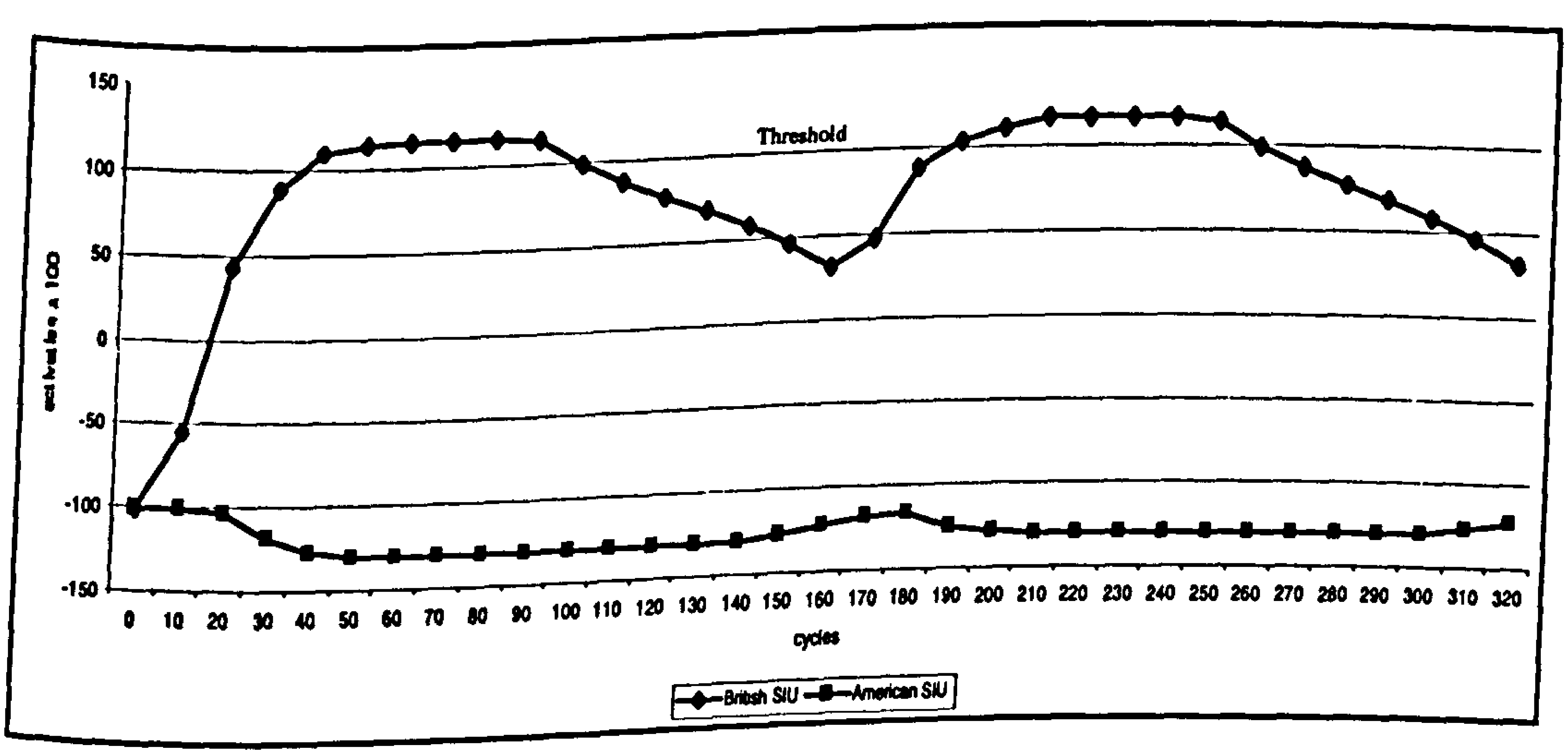
The previous simulations reported here (using data from Burton et al, 1990), modelled semantic priming on to a *familiarity* decision, which occurs at the level of the PINs. Here we will model *semantic* decisions, which are signalled at the level of the SIUs. The following simulations use a recent instantiation of the Burton et al. model, as reported in Young and Burton (1999) (Appendix 1, gives the parameters of this model).

These simulations assume that a push button response in a semantic decision task can be made on the basis of the appropriate SIU reaching threshold. The number of cycles necessary for a unit to reach this threshold may be seen as an estimate of the time necessary to access information represented by this unit. Of course, responses in experiments of this nature require decision processes and motor response processes that are not modelled here. However, both Burton et al. and Brédart et al., make the assumption that these factors are equivalent across different conditions in this type of experiment.

## SIMULATION 2.1

The first demonstration simulates the basic semantic priming effect (i.e., no intervening item), this time using a semantic decision. Figure 2.4 shows the activation levels of two SIUs (British and American) during the sequential activation of the following FRUs: 'Prince Charles' - 'Lady Diana'. In this demonstration, the 'Prince

Figure 2.4

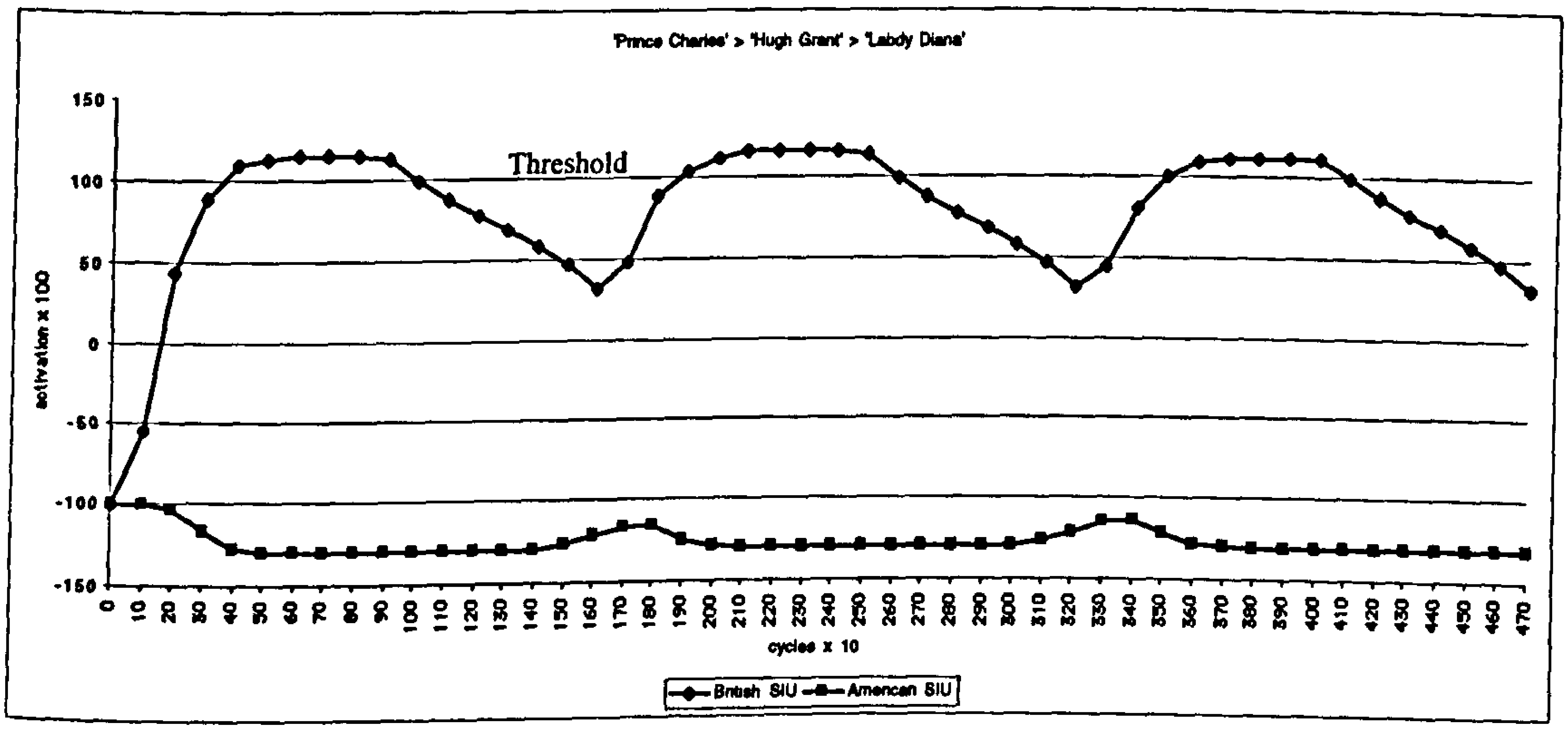


Charles' FRU has been activated, this FRU passes activation to the 'Prince Charles' PIN, and the 'British' SIU consequently becomes active. This 'British' SIU reaches threshold quite quickly (after about 35 cycles), and within-pool inhibition drives the 'American' SIU slightly below it's resting activation. After 80 cycles, activation to the 'Prince Charles' FRU is switched off, and the simulation is run for a further 80 cycles with no external input. During this period, the 'British' SIU falls quickly below threshold, but remains above it's resting level. After this 'inter-stimulus-interval' of 80 cycles, activation is applied to the 'Princess Diana' FRU. Activation flows from the 'Princess Diana' FRU to the PIN and on to the SIUs. As the 'British' SIU starts with above resting activation, it reaches threshold faster than it did when 'Prince Charles' was presented. This simulation therefore predicts that semantic priming should be observed on to a semantic decision. This prediction will be tested in Experiment 1.

## SIMULATION 2.2

The following demonstrations simulate the semantic priming effect on to a semantic decision (nationality) when an intervening item is present. Figure 2.5 shows the activation levels of the same two SIUs (British and American) during the

Figure 2.5



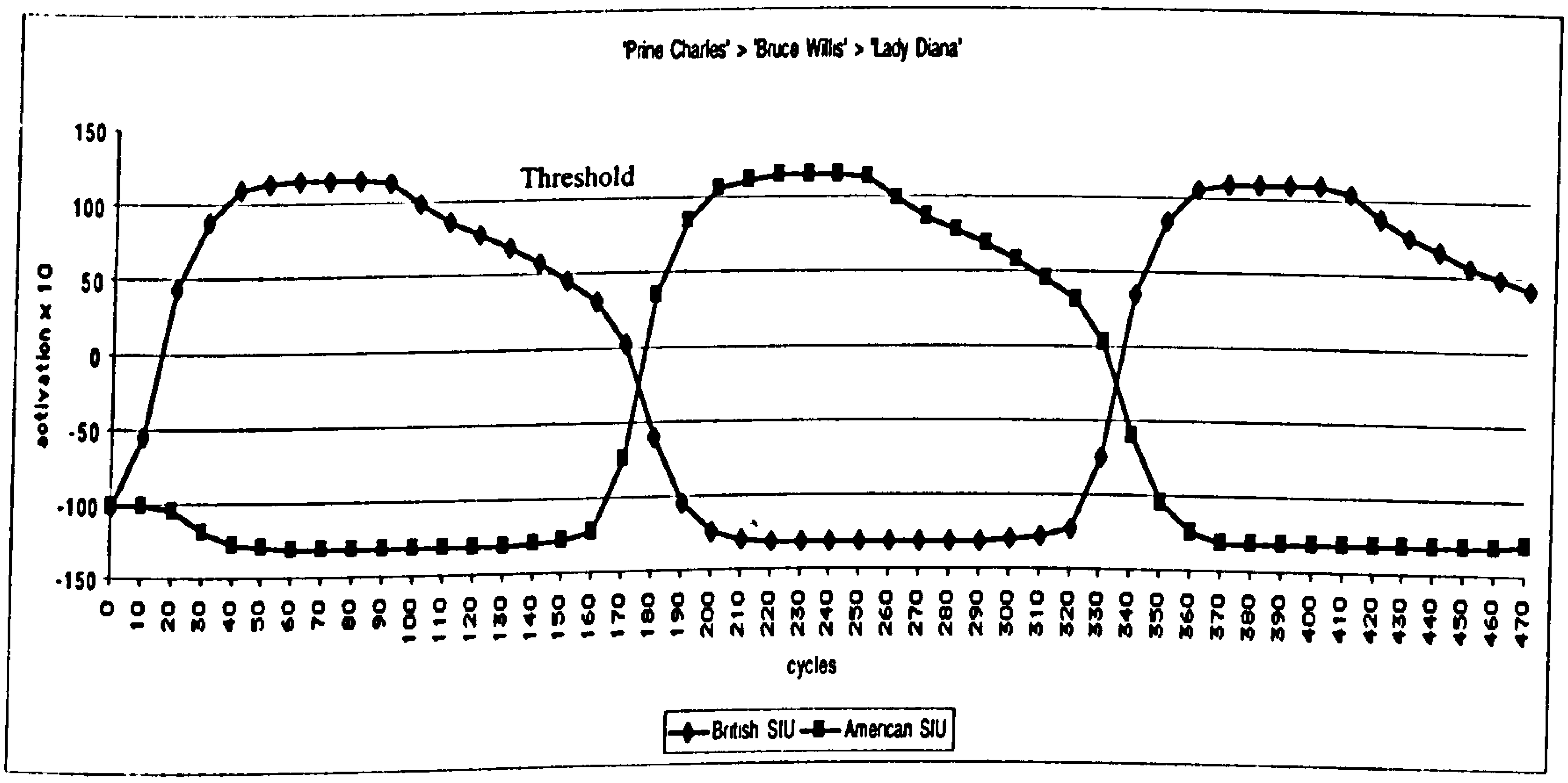

sequential activation of the following FRUs: 'Prince Charles' – 'Hugh Grant' - 'Lady Diana'. 'Hugh Grant' is an unrelated intervening item, which shares nationality with the prime and target. The first 160 cycles in this simulation are exactly as in Figure 2.3; the 'Prince Charles' FRU is activated, followed by 80 cycles with no activation. At this point, the FRU of an unrelated but same nationality item (Hugh Grant) is activated. The simulation shows the effect of this 'intervening item' at the SIUs. Activation flows from the 'Hugh Grant' FRU to the PIN to the 'British' SIU, and it quickly passes threshold. In fact, the 'British' SIU passes threshold just as quickly as it did in the previous simulation, when 'Lady Diana' followed 'Prince Charles'. This simulation therefore predicts that semantic priming, in a semantic decision task, should survive an intervening item, as long as the intervening item shares the property in question with the prime and target stimuli.

An interesting aspect of this simulation is that it appears to suggest that categorially related stimuli pairs (e.g., Prince Charles – Hugh Grant, who are both 'British') should produce just as much priming on to nationality decision, as associatively related pairs (e.g., Prince Charles – Lady Diana, who share many properties). This suggestion appears to be inconsistent with previous studies in this area, which have used a familiarity decision at test. These experiments have consistently shown that stimulus pairs must be very closely related in order for semantic priming to occur (e.g., Barry et al., 1998; Young et al., 1994; though see, Carson & Burton, 2001, for an alternative view). However, the debate about whether these effects are mediated by categorial or associative relationships is not directly relevant to the question that is asked in this chapter and is not discussed further at his point (this issue will be revisited in Chapter 4).

## SIMULATION 2.3

Figure 2.6 shows the activation levels of the same two SIUs (British and American) during the sequential activation of the following FRUs: 'Prince Charles' – 'Bruce Willis' - 'Lady Diana'. 'Bruce Willis' is an unrelated intervening item, which does not share nationality with the prime and target. Again, the first 160 cycles in this simulation are exactly as in Figure 2.3; the 'Prince Charles' FRU is activated, followed by 80 cycles with no activation. At this point, the FRU of an unrelated

Figure 2.6




different nationality item (Bruce Willis) is activated. The simulation shows the effect of this 'intervening item' at the SIUs. Activation flows from the 'Bruce Willis' FRU to the PIN to the 'American' SIU. As the 'American' SIU rises, the 'British' SIU falls. This happens for two reasons. Firstly, there is no external activation flowing to the 'British' SIU, as the input to the 'Prince Charles' FRU has now been switched off. Secondly, in the absence of this external activation, the within-pool inhibition from the "American" SIU (and any other SIUs connected to the 'Bruce Willis' PIN) drives the 'British' SIU down. In these circumstances the 'British' SIU falls quickly below it's resting level.

For the Burton et al. model, these simulations predict that semantic priming in a nationality decision task should survive an intervening item, but only if the intervening item shares nationality with the prime and target. If not, then within-pool inhibition should abolish the priming effect. It is worth emphasising here that it is not within-pool inhibition, per se, which abolishes semantic priming, rather it is the effect of within-pool inhibition in the absence of positive activation to that node which relates to the decision question. If the node in question is receiving positive input, from outside the pool, then standard inhibition, from within, will not overcome this.

The above simulations show, first of all, that it should be possible to observe semantic priming on to a semantic decision. Secondly, they offer the possibility that by using carefully controlled intervening items, within a semantic priming paradigm, it may be possible to differentiate between the models of Burton et al., and Brédart et al. In general terms, if semantic information is stored in an undifferentiated way (as proposed by Burton et al.) then any intervening decision that does not share the decision property with the prime and target might abolish priming. If semantic information is stored in different pools, as suggested by Brédart et al., then only those intervening items, which tap the same representational pool (and which do not share the decision property) as the prime and target have the potential to abolish the priming effect.

According to Burton et al., any decision to an intervening item which does not share the decision property with prime and target should eliminate (or at least reduce) priming. For Brédart et al., only those decisions which are related to semantic nodes within the same pool as the prime and target, should produce a similar reduction in the priming effect.

## EXPERIMENT 2.1

Before looking at the effects of an intervening item on semantic priming in a semantic decision task, it is necessary to establish that the basic semantic priming exists when a semantic decision is used. While semantic priming has been reliably found when a familiarity decision is required (e.g., Bruce & Valentine, 1986; Young et al., 1994), there are no data available relating to semantic priming using semantic decisions. Therefore, in the first experiment we simply ask whether semantic priming of person recognition can be observed when a semantic decision is required at test. As shown earlier, Burton et al.'s IAC model predicts semantic priming onto a semantic decision. Therefore, in this experiment, a similar pattern of responding might be expected for semantic decision conditions as has previously been reported for familiarity decisions (Bruce and Valentine, 1986).

It is a well-established property of semantic priming that the same pattern of results can be observed using either name or face stimuli, and this is accommodated in structural models by proposing that the effect relies on processes which follow convergence of recognition routes for names and faces. For simplicity, this experiment uses name stimuli as both primes and targets.

## Method

### *Participants*

Fourteen undergraduate students from the University of Glasgow participated in the experiment in return for a small payment. In order to ensure that participants were familiar with the critical items, anyone scoring less than 75% correct, in any cell of the design, was replaced.

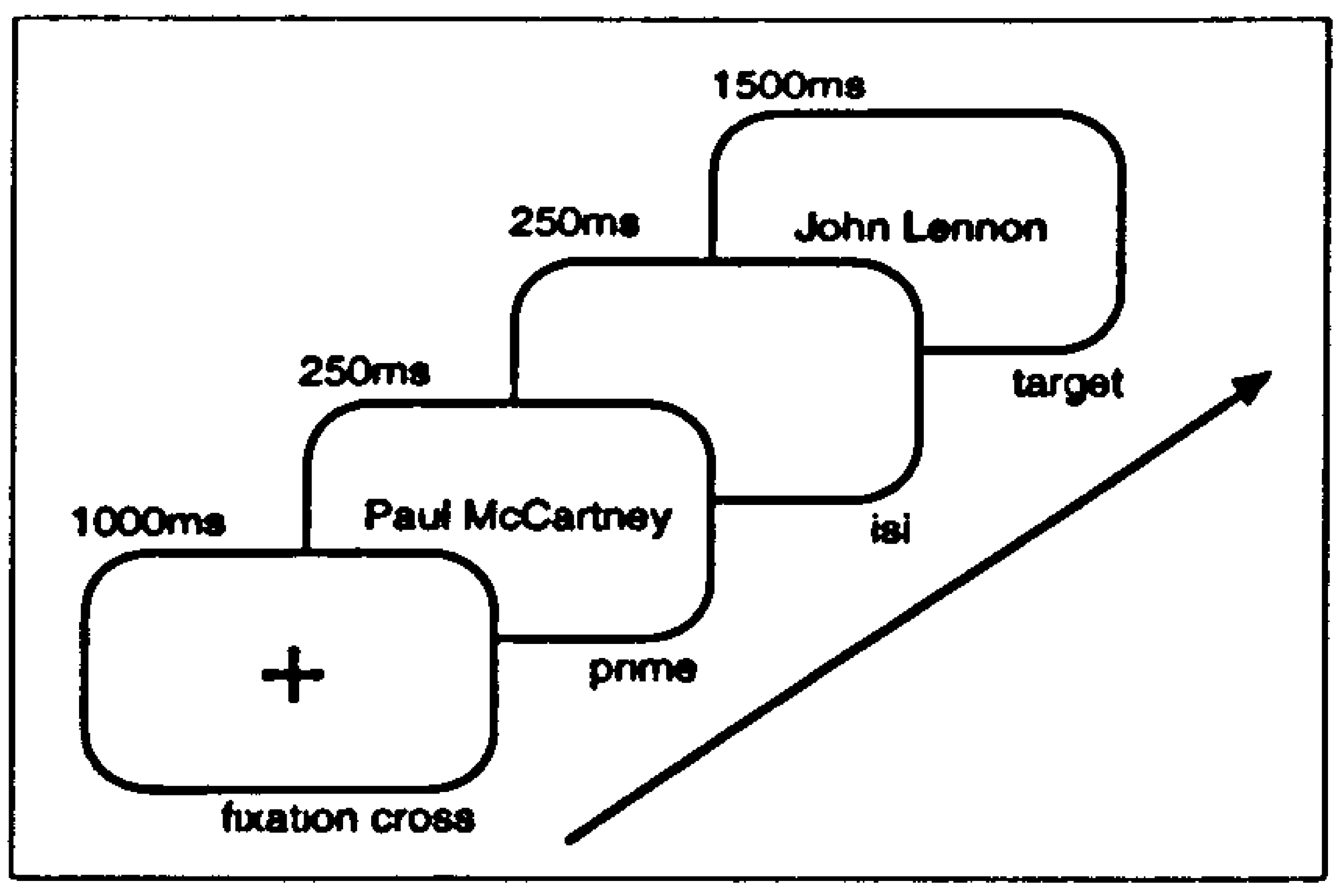
### *Materials*

The critical experimental stimuli were the names of 72 famous people organised into three lists of twelve associated pairs (see Appendix 2). Each list of 12 pairs contained six British and six American name pairs. These lists, combined with a further list of twelve unfamiliar names, were manipulated to construct familiar targets for associated, familiar (but unrelated) and neutral (i.e., unfamiliar) primes. This manipulation resulted in three separate stimulus sets in which target items were fully counterbalanced across the three separate prime conditions. Examples of prime/target stimuli for each condition are as follows: associated condition, Paul McCartney / John Lennon; familiar condition, Tony Blair / John Lennon; neutral condition, Jim Nolan / Prince Charles. All stimuli were presented centrally, in a sans serif font at point size 36, on a computer monitor at a distance of 50cm.

*Design and Procedure*

The experiment comprised one within-subjects factor: prime type with three levels (associated, familiar-unrelated and neutral). Each trial started with a fixation

Figure 2.6




cross, which remained on screen for 1000ms. This was followed by the prime stimulus for a duration of 250ms, followed by an ISI of 250ms, followed by the target stimulus for 1500ms (See Figure 2.6). Participants were instructed to respond quickly and accurately to the second name in this sequence, and were asked to indicate whether this name belonged to a British or American person. Participants responded by pressing one of two buttons on a computer keypad and response latencies were measured from the onset of the target stimuli. All trials were presented in a random order.

## Results

Latencies over two seconds were discarded, as were outliers exceeding the participant mean by two standard deviations for any particular condition. This led to 7.9% of the data being excluded overall. Table 2.1. shows the mean correct RTs and

Table 2.1
Mean RT Data for Correct Decisions
In Experiment 2.1

| *prime type* | *mean RT* | *SD* |
|---|---|---|
| associate | 709 | 206 |
| familiar | 866 | 203 |
| unfamiliar | 894 | 149 |

standard deviations for the different conditions. A single factor ANOVA showed a main effect for prime type $F(2,26) = 14.58, p < 0.05$. For this main effect, a Tukey HSD test revealed differences between the following conditions: associated prime/familiar prime; and associated prime/neutral prime ($p < 0.05$). The same test revealed no differences between familiar prime/neutral prime conditions.

## Discussion

The results, from the semantic decision task used, show reliable facilitation for associated primes as compared to familiar unrelated primes, which themselves do not differ from neutral primes. These results demonstrate for the first time that semantic priming can be observed using a semantic judgement, and are consistent with the idea that the same mechanisms underlie this priming effect, as underlie priming in the traditional familiarity decision task. Above resting levels of activation, at the level of the SIUs, offers a parsimonious explanation of this effect and is consistent with the previous simulations. In the following experiments we investigate how the semantic priming effect observed in Experiment 1 is modulated by different types of intervening items.

# EXPERIMENT 2.2

## Introduction

In the experiments that follow, participants make *nationality* (British/American) decisions to the faces of close associated pairs of people (e.g., Bill Clinton and Hilary

Clinton). Interleaved between these pairs are the faces of other famous celebrities, on which either a *nationality* or *occupation* (actor/singer) decision is required.

The requirement that a decision be made to all items and not just the targets is included in this design to ensure that the semantic information of interest is sufficiently activated. The following experiments will rest on the assumption that when a semantic decision is made, the semantic node relating to that decision has passed a particular activation threshold. It is unimportant that this threshold may be short of its maximum level of activation (MLA). What is important is the idea that a node, which has passed threshold, is approaching its MLA, and should therefore exert great downward pressure on other nodes within the same pool. Any node which is not supported by positive activation, from outside the pool, should be driven toward (or below) its resting level. It will be further assumed that nodes relating to decisions which are not explicitly made remain below threshold level. These nodes will exert limited downward pressure on other nodes within the same pool. The following experiments will test differential predictions of the Burton et al and Brédart et al. models. These differential predictions rest on acceptance of the above assumptions.

To recap, if semantic information is stored in an undifferentiated way (Burton et al.) then any intervening decision that does not share the decision property with the prime and target might abolish priming. On the other hand, if semantic information is stored in different pools (Brédart et al.), then only those intervening items which tap the same representational pool (and which do not share the decision property) as the prime and target have the potential to abolish the priming effect.

## Method

### *Participants*

Thirty-two undergraduate students from the University of Glasgow participated in the experiment in return for a small payment. In order to ensure that participants were familiar with the critical items, anyone scoring less than 75% correct, in any cell of the design, was replaced.

### *Materials*

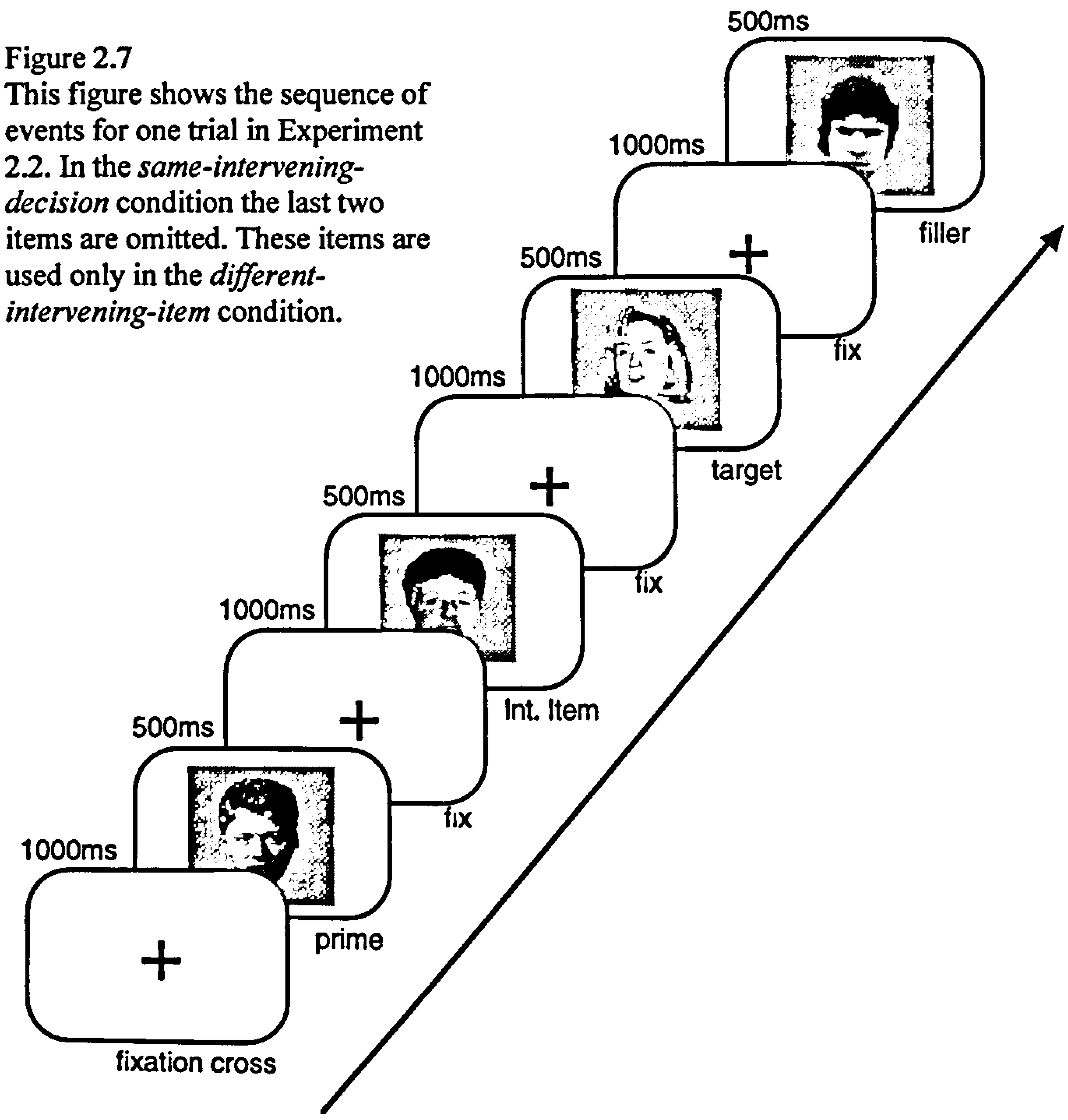
The critical stimuli were 32 closely related face pairs. In addition, 16 faces unrelated to these pairs were used as intervening items. Each trial comprised three stimulus faces presented sequentially. The first and last items were always closely related pairs (e.g., Tony Blair/Cheri Blair). The middle stimulus (the intervening item) was always unrelated to the critical pairs (e.g., David Bowie). For a full list of stimulus items see Appendix 3. The stimuli were viewed on a computer monitor at a distance of 50cm.

*Design and Procedure*

The experiment had two within-subjects factors: *type of intervening decision* with two levels (same vs different); and *nationality of intervening item*, with two levels (same vs different). An intervening decision which taps the same node as the prime and target decisions would not be expected to reduce the priming effect. Therefore, the most interesting comparison will be between the different types of intervening decision (nationality/occupation) when the nationality of the intervening is different from that of the prime and target.

A trial commenced with a fixation cross which remained on screen for 1000ms. This was followed by the prime stimulus for a duration of 500ms, followed by an ISI of 1000ms, followed by the intervening item stimulus for 500ms, followed by an ISI of 1000ms, followed by the target stimulus for 500ms (See Figure 2.7). Participants were instructed to respond as quickly and accurately to the each face in this sequence. The response to the prime and target was always British/American. The intervening response could be either British/American or Actor/Singer depending on *type of intervening decision* condition (same or different). The same/different decisions were presented in separate blocks, and within each block, the order of trials was randomized. Within the *different intervening decision* block, a dummy stimulus was added to the 'prime / intervening-item / target' sequence, in order that decision

Figure 2.7
This figure shows the sequence of events for one trial in Experiment 2.2. In the *same-intervening-decision* condition the last two items are omitted. These items are used only in the *different-intervening-item* condition.




always alternated from one decision (British/American) to the other (Actor/Singer). Therefore, the sequence of stimuli and decisions in this condition always followed the pattern: *prime item*-British/American, *intervening item*-Actor/Singer, *target item*-British/American, *dummy*-Actor/Singer. Pilot work had shown that, without this dummy stimulus, the task was simply too difficult for most participants. All items were presented in a continuous sequence and participants were unaware of the status of each item (prime, intervening-item, target or dummy). Prime and test stimuli were rotated around the intervening items between subjects and block order was counterbalanced between subjects. Participants indicated a decision by pressing one of two buttons on a computer keypad. Response latencies to the prime and target items were measured from the onset of the stimuli. The dependent measure was the difference between the prime and target response times.

## Results

Difference scores were calculated for each trial by subtracting the RT for the target item from that of the prime. An error at either stage resulted in the data from that trial being eliminated from the analysis. Medians of these difference scores were calculated, and means of these by condition are shown in Table 2.2. These difference scores were analysed using a 2(same-intervening-decision vs different-intervening-decision) x 2(same- nationality-intervening-item vs different-nationality-intervening-item) analysis of variance, which showed that the pattern of responding did not differ between the experimental conditions: main effect of intervening decision, $F(1,31)<1$;

**Table 2.2**
Mean Difference RT scores between
prime and target items in Experiment 2.2

| *Status of intervening item* | *Prime* | *Target* | *Difference* | *SD(diffs)* |
|---|---|---|---|---|
| same-decision / same-nationality | 891 | 874 | 17 | 106 |
| same-decision /different-nationality | 877 | 873 | 4 | 106 |
| different-decision / same-nationality | 869 | 845 | 24 | 78 |
| different-decision / different-nationality | 857 | 873 | -16 | 101 |

main effect of intervening nationality, $F(1,31)=2.12$, $p>0.1$; intervening-decision x intervening-nationality interaction, $F(1,31)<1$.

## Discussion

This experiment was designed to test predictions derived from the models of Burton et al and Brédart et al. The non-significant difference between the means of the difference scores in the various conditions suggests one of two conclusions. Firstly, it may be that semantic priming is completely abolished by an intervening item irrespective of the semantic properties of that item, or any decision taken to that item. Secondly, it is possible that the design employed was simply not powerful enough to detect these effects, should they exist.

The first explanation is difficult to accept within the framework of either model, when the results from Experiment 2.1 are taken into account. Experiment 2.1 clearly shows semantic priming on to a semantic decision. Both models might explain these results in terms of advantage produced by 'above resting' activation at the level of the SIUs. If this explanation is correct then there is no reason to suppose that this semantic priming should be abolished by an intervening item which also shares the decision property with the prime and target. However, in this experiment there is no difference between the *same-decision/ same-nationality* condition and the *different-*

*decision/different-nationality* condition. While this comparison was not the primary focus of this experiment, it can be recruited to demonstrate the weakness of the design, because both models would clearly predict that these conditions should differ. In this experiment they do not differ, so this experiment fails to support a very clear prediction of both models. It therefore seems reasonable to suspect that this experiment is simply not powerful enough to detect the type of effects, which are the focus of this study. Another reason to suspect the design employed here is evidenced by the large standard deviations associated with the means of the difference scores, indicating an extremely large variance within each set.

Given that the null effects observed in this experiment, may be due to a lack of experimental power, it is reasonable to test the same predictions using a more powerful design. This is done in the following experiment.

# EXPERIMENT 2.3

## Introduction

This experiment follows the logic of Experiment 2.2 in that, once again, we are looking at the effect of an intervening item between two semantically related pairs of stimuli, this time using a more powerful design. In Experiment 2.2, the dependent measure was the difference in RT scores between the related prime and target stimuli. However, the variance in these difference scores proved to be very large, as evidenced by the SDs reported above. It is therefore possible, that the any effect of the intervening item is being masked in this somewhat noisy design. In the current experiment, the priming effect is measured in terms of an advantage for targets, which are preceded by associated primes, as compared to targets, which are preceded by familiar (but unrelated) primes. This is very similar to the design used in Experiment 2.1, where significant priming was observed. As there was no difference between the unrelated and neutral prime conditions in Experiment 2.1., the neutral condition has been omitted from the design used here. Therefore, the main difference, between this experiment and Experiment 2.1., is that here an intervening item will be presented between the prime and target items. The predictions are the same as in

Experiment 2.2. That is, the Burton et al. model predicts that any intervening decision that does not share the decision property with the prime and target should abolish, or at least reduce, priming. Whereas in the Brédart model, only those intervening items that tap the same representational pool (and that do not share the decision property) as the prime and target, should reduce the priming effect.

## Method

### *Participants*

Forty undergraduate students from the University of Glasgow participated in the experiment in return for a small payment. .

### *Materials*

The critical stimuli were 32 closely related face pairs. In addition, 16 faces unrelated to these pairs were used as intervening items. Each trial comprised of three stimulus faces presented sequentially. The first and last items where always closely related pairs (e.g., Tony Blair/Cheri Blair). The middle stimulus (the intervening item) was always unrelated to the critical pairs (e.g., David Bowie). For a full list of stimulus items see Appendix 4. The stimuli were viewed on a computer monitor at a distance of 50cm.

*Design and Procedure*

The experiment had two within-subjects factors: *type of intervening decision,* with two levels (same vs different); *nationality of intervening decison,* with two levels (same vs different). The dependent measure was the difference in mean RTs scores between targets primed by an associate and targets primed by an unrelated item. Prime and test stimuli were fully rotated around the intervening items, within subjects, such that each stimulus appeared an equal number of times as both prime and target, in each cell of the design.

A trial commenced with a fixation cross which remained on screen for 1000ms. This was followed by the prime stimulus for a duration of 500ms, followed by an ISI of 1000ms, followed by the intervening item stimulus for 500ms, followed by an ISI of 1000ms, followed by the target stimulus for 500ms (See Figure 2.7). Participants were instructed to respond as quickly and accurately to the each face in this sequence. The response to the prime and target was always British/American, therefore the intervening response could be either British/American or Actor/Singer depending on *type of intervening decision* condition (same or different). Each different type of intervening decision was presented in separate blocks, and within each block the order of trials was randomised. Within the different intervening item block, a dummy stimulus was added to the prime-intervening item-target sequence, in order that decision always alternated from one decision (British/American) to the other (Actor/Singer). Therefore, the sequence of stimuli and decisions in this condition always followed the pattern: prime item-British/American, intervening item-Actor/Singer, target item- British/American, dummy-Actor/Singer. As in Experiment 2.2, pilot work had shown that, without this dummy stimulus, the task was simply too difficult for most participants. All items were presented in a continuous sequence and participants were unaware of the status of each item (prime, intervening item, target or dummy) Participants indicated a decision by pressing one of two buttons on a computer keypad. Response latencies to the prime and target items were measured from the onset of the stimuli.

## Results

A score representing the amount of priming for each condition was calculated by subtracting the mean RTs for the associated primes from the mean RTs of the unrelated primes. Means of these difference scores, by condition, are shown in Table 2.3. These difference scores were analysed using a 2(same-intervening-decision vs different-intervening-decision) x 2(same-nationality-intervening-item vs different-nationality-intervening-item) analysis of variance, which showed that the pattern of responding did not differ between the experimental conditions: main effect of intervening decision, $F(1,39)<1$; main effect of intervening nationality, $F(1,39)=2.57$, $p>0.1$; intervening-decision x intervening-nationality interaction, $F(1,39)<1$.

**Table 2.3**
Mean Difference RT scores between
unrelated and associated items in Experiment 2.3

| *Status of intervening item* | *Unrelated* | *Associated* | *Difference* | *SD(diffs)* |
|---|---|---|---|---|
| same-decision / same-nationality | 762 | 720 | 42 | 84 |
| same-decision /different-nationality | 748 | 762 | 14 | 80 |
| different-decision / same-nationality | 915 | 954 | 39 | 109 |
| different-decision / different-nationality | 926 | 911 | 15 | 96 |

## Discussion

Once again, there is a non-significant difference between the levels of priming for the different experimental conditions in this experiment, indicating that semantic priming on to a semantic decision does not survive when a semantic decision is required to an item that intervenes between the prime and target. The failure to find any priming effects here appears to confirm the findings from Experiment 2.2. These results do not allow any formal distinction to be drawn between the Burton et al. and Brédart et al. models. However, the trends in the pattern of responding are very similar to those found in Experiment 2.2. These trends are suggestive of the type of effects that were predicted and are discussed more fully below.

## GENERAL DISCUSSION

This Chapter reports three new simulations and three experiments which seek to illuminate the nature of semantic priming effects on to a semantic decision when modulated by different types of intervening item. The first simulation simply predicts that semantic priming should be found on to a semantic decision. Experiment 2.1 verified this prediction showing an advantage for a semantic decision (British/American) to a target item preceded by an associate item as compared to unrelated items, which did not differ from neutral items. This is the first time that such a priming effect has been reported.

Using the above semantic priming technique, an attempt was made to differentiate between two popular models in this area. Simulations 2.4 and 2.5 suggested that semantic priming on to a semantic decision should survive an intervening item in certain circumstances. However, Experiments 2.2 and 2.3 fail to verify the predictions drawn from these simulations, and in fact appear to indicate that this priming effect does not survive when a semantic decision is required to an intervening item.

The results from Experiment 2.1 are encouraging, in that this new technique (semantic priming onto a semantic decision) appears to offer a way into exploring the structure of the semantic system (an area which has largely been neglected to date). However, when this technique was used in Experiments 2.2 and 2.3, which included an intervening item, the results proved disappointing.

However, the failure to find any reliable effects, in Experiments 2.2 and 2.3, was somewhat surprising, given the predictions drawn from simulations using the Burton et al. model, which were presented in the introduction to this chapter. How are we to interpret the absence of priming effects in Experiments 2.2 and 2.3? One reasonable conclusion is that an intervening item abolishes priming for semantic decisions, just as it does for familiarity decisions (Bruce, 1986). However, a common problem with priming methodology (and hypothesis testing in general) is that it is impossible to establish that a particular effect does not exist, simply because a particular experimental manipulation fails to find it. It may be that the experimental manipulation in question was simply not powerful enough to reveal the effect.

If we look at the trends in the patterns of responding, in Experiments 2.2 and 2.3, we find that these trends are similar in both experiments. Unsurprisingly, there is an advantage for same nationality over different nationality intervening items, when he intervening decision is nationality (13ms in Experiment 2.2; 28ms in Experiment :.3). However, in both experiments, there is an advantage for same nationality, over different nationality intervening items, even when an occupation decision intervenes between two nationality decisions (40ms in Experiemnt 2.2. and 25ms in Experiemnet 2.3), suggesting that the nationality of the intervening item may be predictive, irrespective of the type of decision taken to the intervening item.

Secondly, there is no suggestion that decision type influences the levels of priming found. Both experiments demonstrate only a very small advantage for same decisions over different decisions, when nationality of the intervening item is the same as the prime and target (7ms in Experiment 2.2., and 3ms in Experiment 2.3). Again, there is no suggestion of an advantage for same decisions over different decisions, when nationality of the intervening item is different (1ms difference in Experiment 2.3). There is a 20ms difference between these conditions in Experiment 2.2. but this difference is particularly spurious as it relies on the prime items being responded to faster than the targets items. The rotation of the prime and target items (described fully in the methods section) should prohibit such a pattern of responding, so this trend should be viewed with particular scepticism.

Taken together these trends suggest that decision type (nationality or occupation) does not influence the magnitude of the priming effect. This is consistent with the Burton et al. account, inasmuch that it suggests that both a nationality and an occupation decision, intervening between two nationality decisions, produce equivalent effects. Also, in Experiment 2.3 there appears to be no difference between the same-decision/ different-nationality and different-decision/different-nationality conditions (1ms difference), which was a specific prediction of this model. Brédart et al., in contrast, would predict that there should be a difference between these conditions. However, it is acknowledged that this suggestion is tenuous given there are no significant effects.

However, all of these interpretations rest on the assumptions set out in the introduction to Experiment 2.1. These were: (1) that nodes relating to decisions which are made are approaching their MLA and should therefore exert great downward pressure on other nodes within the same pool, and (2) that nodes relating to decisions which are not explicitly made remain below threshold level, and therefore exert limited downward pressure on other nodes within the same pool. In the absence of any indication that decision type modulates these priming effects, this assumption may have to be reviewed. If these assumptions prove incorrect, then both models would provide an adequate explanation of the trends reported above.

While the data from Experiments 2.2 and 2.3 do not permit any formal conclusions to be drawn, the fact the trends in both experiments are so similar suggests that it may be worthwhile to further investigate these effects using a different type of experimental approach. This is achieved in Chapter 3, which investigates the structure of semantic memory using an interference technique instead of priming paradigm that was employed here.

# CHAPTER THREE

*Exploring Interference Effects*

## OVERVIEW

The previous Chapter looked at the organisation of semantic memory for familiar people by comparing two broad models in this area (Burton et al., 1990; Valentine, Moore, & Brédart, 1995). In this chapter, a second attempt is made to differentiate between these competing accounts, using an interference technique instead of the semantic priming technique employed in the previous chapter.

While this technique has been used extensively to probe other psychological phenomena (Glasser & Düngelhoff, 1984; Rosinski, Golinkoff, & Kukish, 1975), there are few examples of its use in the area of person recognition. In this area, this technique was first used by Young, Ellis, Flude, McWeeny and Hay (1986). These authors presented participants with stimuli which were composed of a famous face (either politician or pop star) from which extended a speech bubble, which contained a famous person's name (again, belonging to either a politician or pop star). Their findings suggest that subjects were unable to prevent semantic categorisation of face and name stimuli under certain experimental conditions. Specifically, they found that, when presented simultaneously, faces interfered with name classification (politician or pop star), and that names interfered with face classification (again, politician or pop star), although to a lesser extent (Young et al., Experiment 4). The important point, as far as the present study is concerned, is that the patterns of interference observed can be interpreted as being determined by semantic properties of the stimuli. Essentially, when the face and name are incongruent in respect of occupation (e.g., Mick Jagger / Neil Kinnock) an occupation decision was slower than when they were congruent (e.g., Mick Jagger / Paul McCartney).

Interactive activation and competition models of person recognition (i.e., Burton et al., 1990; Brédart et al, 1995), can account for these findings by appealing to the speed at which activation levels rise at certain SIUs. For example, stimuli that are congruent in respect of occupation (e.g., Mick Jagger and Paul McCartney) will both activate the 'pop star' SIU. This double hit at 'the pop star' SIU may allow this SIU to reach its threshold faster, and could provide a parsimonious explanation of any RT advantage found. Stimuli that are incongruent in respect of occupation (e.g., Mick Jagger and Neil Kinnock), will produce activation simultaneously at the 'pop star' and 'politicain' nodes. In these circumstances, each node will impede the rise in activation at the other, via the mechanism of within-pool inhibition. This within-pool inhibition (explained in detail in the previous chapter) can also be recruited to explain the interference found in this condition of the Young et al. study. It is therefore possible that both of these factors contribute to the RT advantage for the semantically congruent stimuli over the semantically incongruent stimuli. However, Young et al. (1986) showed that a speech bubble containing the name of the simultaneously presented face, and a speech bubble containing the name of a person from the same occupational category as the face, produced equivalent responses on to an occupation decision to the face (Experiment 4). In fact, there was no difference between these conditions and the condition in which faces were presented alone (i.e., with empty speech bubbles). This evidence would appear to rule out the 'double hit' hypothesis and suggests that within-pool inhibition is the major contributor to the observed effects.

In summary, the findings from Young et al. (1986) suggest, firstly, that semantic classification of distractor stimuli occurs automatically and is unstoppable. Further, stimuli that are semantically incongruent produce reliable interference effects when a semantic decision is required. It is this interference effect that will be recruited in the following experiments.

Following Young et al. (1986) faces will again be presented simultaneously with distractor stimuli, which may be semantically congruent or incongruent with semantic properties of the face. However, this time the distractors will be icons (e.g., an American flag) as opposed the name stimuli utilised by Young et al. (1986). In theory, a distractor icon which is incongruent with a property of the face should produce interference when a semantic decision to the face is required. For example, an American flag distractor should interfere with a British decision to the face.

An extension of this logic provides a new way to discriminate between the models under investigation. Clearly a 'American' distractor should interfere with a 'British' decision and both models would predict this. However, will an 'American' distractor interfere with a 'pop star' decision? The Burton et al. model predicts that it should, whereas the Brédart et al. model predicts that it should not. The reasoning, which supports these predictions, is as follows. In the Brédart et al. model, activation at the 'pop star' node should produce some within pool inhibition, but only within the occupation pool. This should have no effect within the nationality pool, and should therefore not impede the rise in activation at the 'American' node. However, in the Burton et al. model all semantic information is stored in one large pool. In this case, activation at the 'pop star' node should impede the rise in activation at the 'American' node and interference should be observed.

# EXPERIMENT 3.1

## Introduction

The target stimuli in the following experiments are faces with certain semantic properties (British, American, film star, pop star). These faces will be presented combined with icons, which also represent these properties. The patterns of interference observed will be assessed within the competing frameworks of the Burton et al. and Brédart et al. models.

Detailed predictions of both models are now considered. If the decision required to the face is compatible with the icon (Al Pacino with an 'American' flag) then both models might predict that a nationality decision would be facilitated, in these circumstances. The reason for this is that the 'American' SIU is receiving activation from two sources. In the normal way activation will flow from the 'Al Pacino' FRU to the PIN to the 'American' SIU. At the same time, this 'American' SIU should receive activation from the 'American' flag, either directly, or perhaps indirectly, via links to an object recognition system. Whether or not this 'American' node receives this activation directly (implying that face and object recognition systems share the same semantic store), or indirectly, is not important to the argument made here. The point is that it will receive activation simultaneously from two sources. Compare this with the situation where the icon is incompatible with the nationality of the face (Al Pacino with 'British' flag). Here one might expect that the British flag would activate the 'British' SIU and that rising activation at this node would inhibit the rise in activation at the 'American' SIU, making it slower to reach its activation threshold. So far, both models would predict the same outcome in both of the situations described above, as the distractor icon, which produces the facilitation or interference effect, is contained within the same pool as the 'American' node. As discussed earlier, the Young et al. (1986) study indicated that congruent distractors do not produce facilitation, and it is unclear whether or not observable facilitation will occur in the circumstances just described. Irrespective of this, however, the interference effect should be detectable, and both models predict interference in these circumstances.

Now let us consider what might happen if congruent *occupation* icons are presented alongside the faces when a *nationality* decision is required. Let us say that the face of Al Pacino is presented alongside a 'film star' icon and that a nationality decision is required.

In the Burton et al. model, we have one pool of semantic information, therefore any node which is active within this pool should inhibit any other node. Therefore, an active 'film star' node should impede the rise in activation at the 'American' node. However, as Al Pacino *is* a film star, this 'film star' node will already be receiving activation in the normal way, from the face, via the usual route (FRU > PIN > 'film star' SIU). So the question is, should extra activation at this 'film star' node (from the film star icon) produce a measurable inhibitory effect at the 'American' SIU? This question can be answered by appealing to the 'double hit' hypothesis assessed earlier in this Chapter. If extra activation from a shared property at a given node does not produce a measurable facilitation effect (which it does not, Young et al., 1986), then there is no principled reason to suppose that it should produce a measurable inhibitory effect.

However, consideration of Young et al.'s results, highlight a potential problem with the Burton et al. account. This problem has been already been pointed out by other authors (Valentine et al., 1995) and can be summarised as follows. If we know many things about a person, then within-pool inhibition should make it more difficult to retrieve an individual property of that person. This anomaly is easily resolved by acknowledging that SIUs are connected not only through inhibitory links, but also indirectly through excitatory links to the PINs which share these particular properties. Burton, Bruce and Hancock (1999) point out that it is entirely feasible that two semantic units that are both properties of the person in question may have a net connectivity which is positive, despite the fact that there is a single within-pool inhibitory link connecting them directly. This proposition suggests that 'shared properties' should not inhibit one another (as net connectivity will be positive) and is consistent with the Young et al. data.

In summary, the Burton et al. model predicts that there should be no observable interference, on to nationality decision, when the face of 'AL Pacino' is presented alongside an icon representing the property of 'film star'. Deriving a prediction for this condition in the Brédart et al. model is simpler. Any inhibitory effect of the 'film star' icon will be contained within the occupation pool, so no interference effects should be observed on to a nationality decision.

Potentially more revealing is the situation, where a 'pop star' icon is presented alongside, say, Al Pacino, when a nationality decision is required. In this situation, an additional node, and one that is not associated with a property of the person in question, is being activated. It is important to note here that net connectivity between the 'pop star' and 'American nodes cannot be positive in this case, as 'pop star' is not a property of 'Al Pacino'. In the Burton et al. model, inhibition from this unrelated 'pop star' node should impede the rise in activation at the 'American' node.

Therefore, one might expect interference effects in these circumstances. If we compare this with the predictions of the Brédart et al. model, we notice a different outcome. The nodes associated with icons that are unrelated to the nationality of the face, should not impede the rise in activation at the nationality node, as they are not contained within the same pool. Therefore, the Brédart model predicts no interference from the semantic properties associated with the icons under these circumstances. In this condition, the Burton et al. and Brédart et al. models should therefore predict different patterns of interference.

An advantage of this current methodology is that the icons should activate essentially *only* one semantic node. In the experiments in the previous chapter, the effect of the intervening person was felt not only at the node associated with the decision, but also at other nodes associated with any particular property of that person. So, in the previous experiments, in order to claim that the models made differential predictions it was necessary to make the assumption that some nodes (the decision nodes) exert more downwards pressure than others (the non-decision nodes). This assumption was called into question in the discussion section in Chapter 1. No such assumption is necessary here because the icons activate one node only. That is, a 'British Flag' will activate only the 'British' node. Of course some activation will flow from this node to other British people and may subsequently cause activation to flow back to other semantic units, which are related to these particular individuals. However, this second order activation should have a relatively minor effect in comparison to the first order activation from SIU related to the icon itself.

In summary, the most interesting comparison, in terms of comparing the predictions of the models, is between the *decision-congruent* and *decision-incongruent* conditions when the stimuli are incongruent: Brédart et al. predicts a difference between these conditions, whereas Burton et al. does not.

## Method

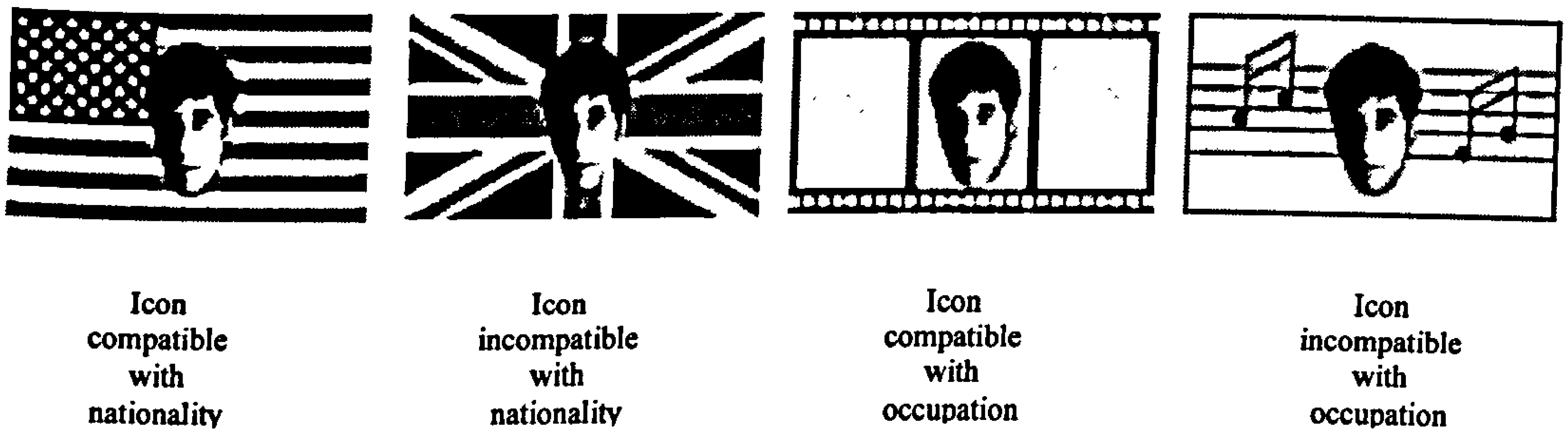
### *Participants*

Twenty undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

### *Materials*

The critical experimental stimuli were the faces of 32 famous people. This list comprised of 8 British pop stars, 8 British film stars, 8 American pop stars, and 8 American film stars. Each face was paired with one four different icons, which could be compatible or incompatible with their nationality or occupation. Examples of stimuli are shown below in Figure 3.1. All face images were edited to remove background material and clothing, leaving only the face and hair. Images were

**Figure 3.1**
This figure shows examples of the stimuli used in Experimant 3.1




standardised to have height 6cm, pasted centrally onto the icon background, and viewed on a computer monitor at a distance of 50cm.

*Design and Procedure*

The experiment tested both nationality and occupation decisions across two within-subjects factors. The decision taken to the target face could be either congruent or incongruent to the distractor icon, and the target face itself could be either congruent or incongruent with the distractor icon. This first factor is therefore labelled *decision* and it has two levels (congruent vs incongruent); the second factor is labelled *stimuli*, with two levels (congruent vs incongruent). Each of these conditions (illustrated in Fig 3.1,) were paired with a nationality or occupation decision, producing eight experimental conditions in total. Each trial started with a fixation cross, which remained on screen for 1000ms. This was followed by the stimulus, which remained on screen until a decision was made, followed by an ISI of

1000ms. Participants were instructed to ignore the background icon and respond as quickly and as accurately as possible to the face. Participants made nationality or occupation decisions to each face depending on condition. They responded by pressing one of two buttons on a computer keypad and response latencies were measured from the onset of the stimuli. Nationality and occupation decisions were presented within separate blocks, with block order counterbalanced between subjects. All trials were presented in a random order within each block.

## Results

Table 3.1a and 3.1b show the mean correct RTs and error rates for the different conditions. In this and in subsequent experiments latencies over two seconds were

**Table 3.1a**

This table shows the mean response latencies, standard deviations and errror rates for the different conditions for the nationality decisions in Experiment 3.1

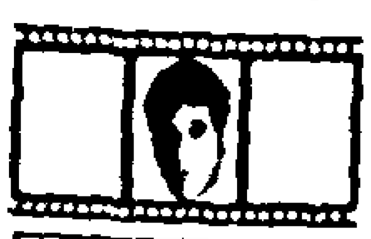
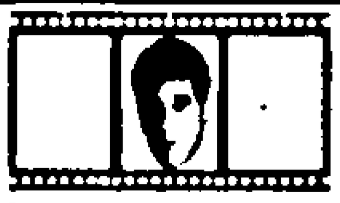
| | condition | mean RT | SD | error rate (%) |
|---|---|---|---|---|
|  | Decision Congruent / Stimuli Congruent | 831 | 90 | 10 |
|  | Decision Congruent / Stimuli Incongruent | 876 | 112 | 12 |
|  | Decision Incongruent / Stimuli Congruent | 844 | 96 | 11 |
|  | Decision Incongruent / Stimuli Incongruent | 838 | 104 | 11 |

**Table 3.1b**

This table shows the mean response latencies, standard deviations and
errror rates for the different conditions for the occuaption decisions in Experiment 3.1

| | *condition* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
|  | Decision Congruent / Stimuli Congruent | 804 | 98 | 10 |
|  | Decision Congruent / Stimuli Incongruent | 801 | 92 | 13 |
|  | Decision Incongruent / Stimuli Congruent | 843 | 98 | 13 |
|  | Decision Incongruent / Stimuli Incongruent | 853 | 104 | 13 |

discarded, as were outliers exceeding the participant mean by two standard deviations, for any particular condition. This led to 2.9% of the raw data being excluded. Incorrect responses accounted for a further 11.5% of the total data. The error rate data for nationality and occupation decisions were analysed separately, using a 2 (decision-congruent vs decision-incongruent) x 2(stimuli-congruent vs stimuli-incongruent) ANOVA, which showed that the error pattern did not differ between the experimental conditions. For nationality decisions, the main effect of *decision* was non-significant, $F(1,19) < 1$, as was the main effect of *stimuli*, $F(1,19) = 1.10$, $p > 0.1$, as was the *decision* x *stimuli* interaction, $F(1,19) = 2.67$, $p > 0.1$. For occupation decisions, the main effect of *decision*, was non-significant $F(1,19) = 2.22$, $p > 0.1$, as was the main effect of *stimuli*, $F(1,19) = 2.59$, $p > 0.1$, as was the *decision* x *stimuli* interaction, F(1,19) = 1.08, $p > 0.1$. These error rates will not be discussed further.

RT data for nationality and occupation decisions were analysed separately, using a 2 (decision-congruent vs decision-incongruent) x 2(stimuli-congruent vs stimuli-incongruent) ANOVA. For the nationality decisions, the main effect of *decision* was non significant, $F(1,19) = 1.37$, $p > 0.1$, as was the main effect of *stimuli*, $F(1,19) = 1.72$, $p > 0.1$. The *decision* x *stimuli* interaction was significant F(1,19) = 8.42, $p < 0.05$. An analysis of simple main effects showed a significant difference (45ms) between *stimuli-congruent* and *stimuli-incongruent* items, when the decisions were congruent, F(1,19) = 4.54, $p < 0.05$. There was also a significant difference between *decision-congruent* and *decision-incongruent* items when the stimuli were incongruent, F(1,19) = 6.31, $p < 0.05$. There was no difference between *stimuli-congruent* and *stimuli-incongruent* items when the decision was incongruent F(1,19) < 1. Also, there was no difference between *decision-congruent* and *decision-incongruent* when the stimuli were congruent F(1,19) < 1.

For the occupation decisions, the main effect of *decision* was significant, $F(1,19) = 15.34$, $p < 0.05$. The main effect of *stimuli* was non significant, $F(1,19) < 1$, as was the *decision* x *stimuli* interaction F(1,19) = 0.20, $p > 0.1$.

## Discussion

Like Experiments 2.2 and 2.3, the current experiment was designed to test predictions derived from the models of Burton et al. and Brédart et al. For nationality decisions, the faster responding when the stimuli are congruent, as opposed to incongruent, when the decisions are congruent, indicates that an opposing flag does indeed cause interference, and both models predicted this outcome. However, the slower responding, for *decision-congruent* items over *decision-incongruent* items, when the stimuli were incongruent is more interesting. This result appears to offer tentative support for the Brédart et al model, as an incongruent flag icon appears to produce more interference than an incongruent occupation icon, when the decision is nationality. The Burton et al. model, with its undifferentiated semantics, predicts that interference should be equivalent in both conditions. This conclusion is further supported by the lack of any difference between congruent and incongruent items when the decision was incongruent. Here participants are making a nationality decision to a face, which is accompanied by an congruent or incongruent occupation icon. For the Brédart et al model, increased activation levels within the occupation pool should not effect activation levels in the nationality pool. However, according to Burton et al., an incongruent occupation icon should produce more interference than a congruent occupation icon, especially on to a nationality decision, as the incongruent icon should produce additional within pool inhibition.

The results from the occupation decision condition show a main effect of decision, with congruent decisions being reacted to faster than incongruent decisions, in the absence of a *stimuli* main effect and a *decision x stimuli* interaction. This finding is difficult to reconcile with the results from the nationality decision condition. Firstly, these results show that responding is faster when decisions are congruent as opposed to incongruent. In the absence of other effects, these results indicate that congruent and incongruent stimuli produce equivalent effects for both congruent and incongruent decisions. This pattern of responding is inconsistent with the predictions of both models. Further, the clear difference between *decision-congruent* items and *decision-incongruent* items, when the stimuli were incongruent is in the opposite direction to difference found between the same conditions in the nationality condition. Here an incongruent nationality icon is producing more interference on to an occupation decision, than an incongruent occupation icon. This pattern of responding is again inconsistent with the predictions of both models, but is particularly difficult to explain within the Brédart et al. framework. Why should a concept that is stored in the occupation pool produce inhibition on to a decision which relies on activation levels within the nationality pool?

Overall, the patterns of responding in this experiment are inconsistent and fail to offer reliable evidence in support of either model. A final attempt will be made in the following experiment to distinguish between these models, this time using a design that is very similar to that used by Young et al (1986).

# EXPERIMENT 3.2

## Introduction

In the following experiment, faces with certain semantic properties (British, American, actor, singer), will be presented combined with 'speech bubbles' (instead of the icons used in Experiment 3.1) which indicate these properties. The logic here is exactly the same as in Experiment 3.1. The only difference is that a speech bubble containing words which represent the semantic properties will be used instead of the icons, which were used in Experiment 3.1. Congruent and incongruent speech bubbles are expected to produce the same pattern of responding as was expected in Experiment 3.1.

The Burton et al. model, with its undifferentiated semantics predicts that occupation 'speech bubbles' that are incongruent with the face should produce just as much interference on to a nationality decision as a *different* nationality 'speech bubble' (and vice versa). This is because the effect of the 'speech bubble' will be felt equally, by the appropriate nationality node, in both conditions. The Brédart et al. model predicts that different nationality 'speech bubbles' should produce more interference, on to a nationality decision, than incongruent occupation 'speech bubbles'. This is because the effect of the different nationality 'speech bubble' will be felt within the nationality pool, and the effect of the incompatible occupation 'speech bubble' will be felt only within the occupation pool. Interference, which occurs within the occupation pool, should have no effect within the nationality pool and should not impair the processing of a nationality decision.

## Method

### *Participants*

Twenty undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

*Materials*

The critical experimental stimuli were the faces of 32 famous people. This list comprised of 8 British Pop Stars, 8 British Film Stars, 8 American Pop Stars, and 8 American Film Stars. Each face was paired with one four different speech bubbles, which could be compatible or incompatible with their nationality or occupation. These speech bubbles were presented, an equal number of times, both right and left of

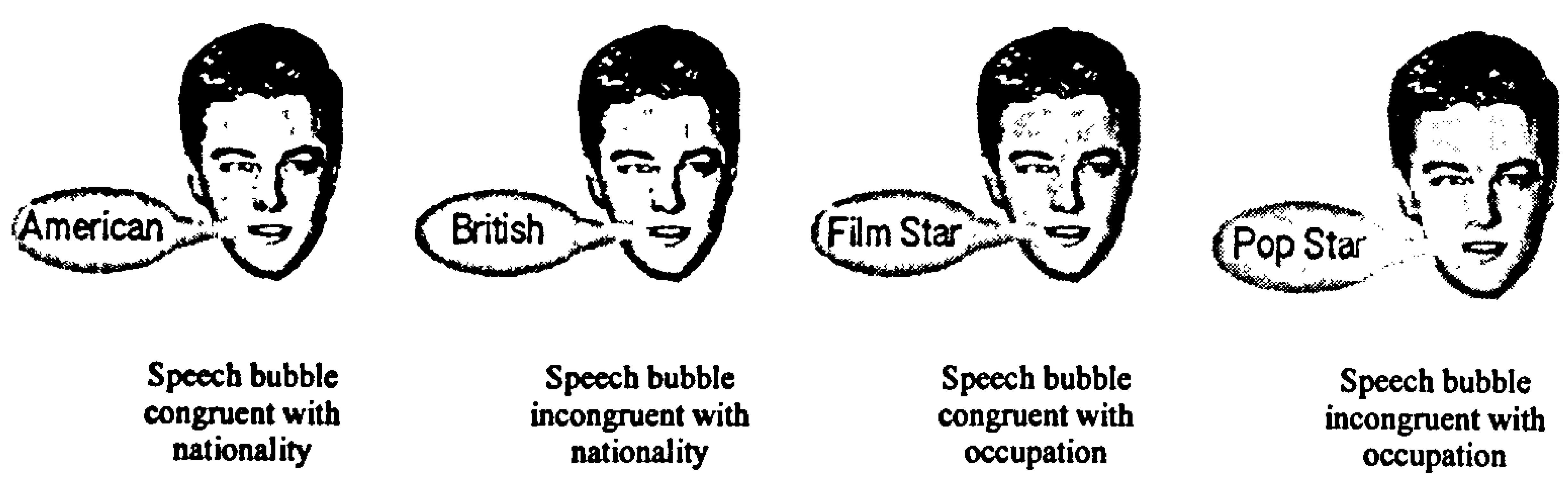



**Figure 3.2**
This figure shows examples of the stimuli used in Experiment 3.2. Please note that while the 'speech bubble' is shown on the left-hand side of the face in these examples, it appears equally often on the right-hand side within the experiment.

the target faces. All face images were edited to remove background material and clothing, leaving only the face and hair. Images were standardised to have height 6cm, and viewed on a computer monitor at a distance of 50cm. Examples of the stimuli are shown in Figure 3.2 .

*Design and Procedure*

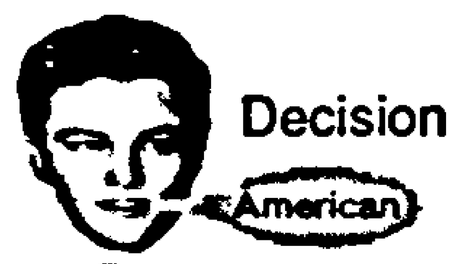
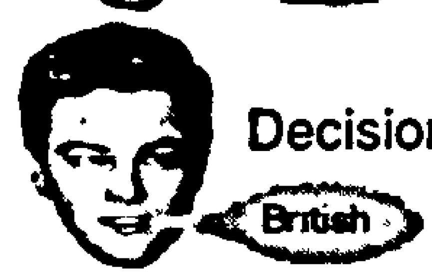
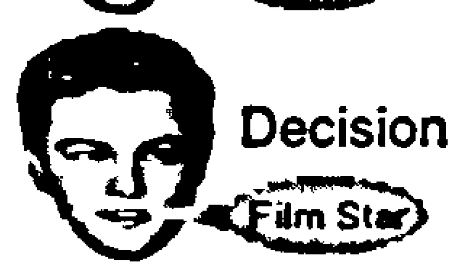
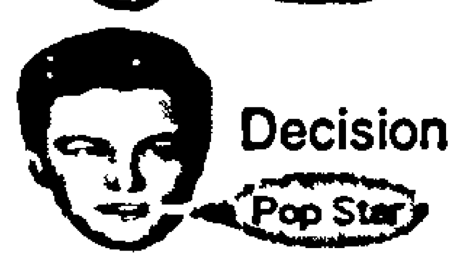
The experiment tested both nationality and occupation decisions across two within-subjects factors. The decision taken to the target face could be either congruent or incongruent with the speech bubble, and the target face itself could be either congruent or incongruent with the speech bubble. This first factor is therefore labelled *decision* and it has two levels (congruent vs incongruent); the second factor is labelled *stimuli*, with two levels (congruent vs incongruent). Therefore, this design produces a total of eight experimental conditions. Each trial started with a fixation cross, which remained on screen for 1000ms. This was followed by the stimulus, which remained on screen until a decision was made, followed by an ISI of 1000ms. Participants were instructed to ignore the 'speech bubble' and respond as quickly and as accurately as possible to the face. Participants made nationality or occupation decisions to each face depending on condition. They responded by pressing one of two buttons on a computer keypad and response latencies were measured from the onset of the stimuli. Nationality and occupation decisions were presented within separate blocks, with block order counterbalance between subjects. All trials were presented in a random order within each block.

## Results

Tables 3.2a and 3.2b show the mean correct RTs and error rates for the different conditions. In this and in subsequent experiments latencies over two seconds were discarded, as were outliers exceeding the participant mean by two standard deviations, for any particular condition. This led to 1.2% of the raw data being excluded. Incorrect responses accounted for a further 10.6% of the total data. The error rate data for nationality and occupation decisions were analysed separately, using a 2 (decision-congruent vs decision-incongruent) x 2(stimuli-congruent vs stimuli-incongruent) ANOVA. For nationality decisions, the main effect of decision was non significant $F(1,17) = 1.23$, $p > 0.1$, as was the decision x stimuli interaction. The main effect of stimuli was only marginally significant, $F(1,17) = 4.45$, $p = 0.049$. For the occupation decisions, the main effect of *decision* was non significant, $F(1,17) < 1$, as was the main effect of *stimuli*, $F(1,17) < 1$, as was the *decision* x *stimuli* interaction $F(1,17) = 1.17$, $p < 0.1$. These error rates will not be discussed further. RT data for nationality and occupation decisions were analysed separately, using a 2 (decision-congruent vs decision-incongruent) x 2(stimuli-congruent vs stimuli-incongruent) ANOVA. For the nationality decisions, the main effect of *decision* was non significant, $F(1,19) < 1$. The main effect of *stimuli* was significant, $F(1,17) = 11.57$, $p < 0.5$. The *decision* x *stimuli* interaction was also significant $F(1,17) = 11.58$,

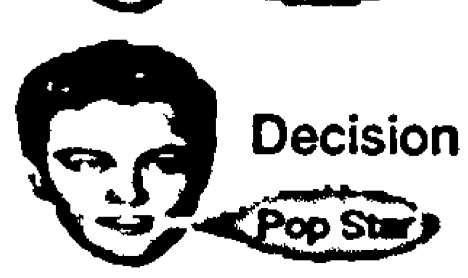
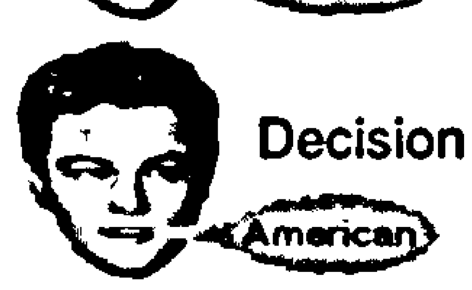
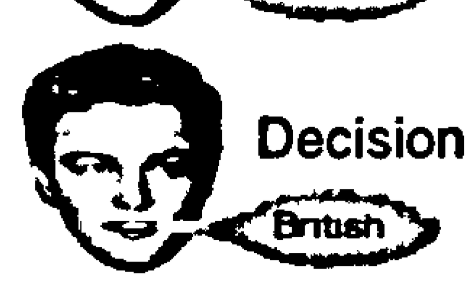
## Table 3.2a

This table shows the mean response latencies, standard deviations and error rates for the different conditions for the nationality decisions in Experiment 3.2

| | *condition* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
|   | Decision Congruent / Stimuli Congruent | 708 | 98 | 11 |
|   | Decision Congruent / Stimuli Incongruent | 757 | 116 | 14 |
|   | Decision Incongruent / Stimuli Congruent | 727 | 102 | 14 |
|   | Decision Incongruent / Stimuli Incongruent | 734 | 103 | 13 |

## Table 3.2b

This table shows the mean response latencies, standard deviations and errror rates for the different conditions for the occuaption decisions in Experiment 3.2

| | *condition* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
|   | Decision Congruent / Stimuli Congruent | 744 | 101 | 8 |
|   | Decision Congruent / Stimuli Incongruent | 773 | 113 | 9 |
|   | Decision Incongruent / Stimuli Congruent | 762 | 113 | 8 |
|   | Decision Incongruent / Stimuli Incongruent | 758 | 115 | 8 |

$p < 0.5$. An analysis of simple main effects showed a significant difference between *stimuli-congruent* and *stimuli-incongruent* items, when the decisions were congruent,

$F(1,17) = 17.92$, $p < 0.05$. There was also a significant difference between *decision-congruent* and *decision-incongruent* items when the stimuli were incongruent, $F(1,17) = 5.60$, $p < 0.05$. There was no difference between *stimuli-congruent* and *stimuli-incongruent* items when the decision was incongruent $F(1,17) < 1$. Also, there was no difference between *decision-congruent* and *decision-incongruent* when the stimuli were congruent $F(1,17) = 3.77$, $p > 0.05$.

For the occupation decisions, the main effect of *decision* was non significant, $F(1,17) < 1$, as was the main effect of *stimuli*, $F(1,17) = 3.44$, $p > 0.05$. The *decision* x *stimuli* interaction was significant $F(1,17) = 10.79$, $p < 0.05$. An analysis of simple main effects showed a significant difference between *stimuli-congruent* and *stimuli-incongruent* items, when the decisions were congruent, $F(1,17) = 9.35$, $p < 0.05$. All other simple main effects were non significant.

## Discussion

Like the previous experiments, the current experiment was designed to test predictions derived from the models of Burton et al. and Brérdart et al. Looking first at the nationality decisions, the faster responding when the face and speech bubble are congruent as opposed to incongruent, and when the decisions are congruent, indicates that an incongruent nationality speech bubble does indeed cause interference on to a nationality decision, and both models would predict this.

Again, however, the slower responding for *decision-congruent* items, over *decision-incongruent* items, when the stimuli were incongruent is more interesting. This result is again consistent with the predictions of the Brédart et al model, as an incongruent nationality speech bubble appears to produce more interference than an incongruent occupation speech bubble, when the decision is nationality. The Burton et al. model, with its undifferentiated semantics, predicts that interference should be equivalent in both conditions. This conclusion is again supported by the lack of any difference between congruent and incongruent items when the decision was incongruent. According to Burton et al., an incongruent occupation 'speech bubble' should produce more interference than a congruent occupation 'speech bubble' on to a nationality decision, as the incongruent icon should produce additional within pool inhibition.

The results from the occupation decision condition, when the decision is congruent, show faster responding when the face and speech bubble are congruent, as opposed to incongruent, indicating that an incongruent occupation speech bubble does indeed cause interference on to a occupation decision. Once again, this is a prediction of both models.

This time however there is no advantage for *decision-congruent* items, over *decision-incongruent* items, when the stimuli are incongruent. For clarity, when participants are asked to make an occupation decision to 'Al Pacino', the presence of 'British' or 'pop star' speech bubbles produce equivalent interference. This result is consistent with the predictions of the Burton et al model. In this model, all semantic information is contained within the same pool, so activation at any node which does not represent a property of the person in question, should impede the rise in activation at any node, which does represent a property of the person (in this instance the 'film star' SIU).

## General Discussion

Once again, the data reported do not provide strong support for either model. The starting point for this research was that current models of semantic memory for familiar people are unsatisfactory. An attempt to differentiate between two popular, and competing, models has been made over the course of four experiments (2.2, 2.3, 3.1 an 3.2). These experiments have failed to find reliable support for either model and have failed to produce any real new insights into how this information is structured. It may well be that these experiments lacked the experimental power necessary to reveal the differential effects which were sought. However an alternative explanation for inconsistent pattern of results may be found in the stroop/response conflict literature. A key feature underlying such accounts is the idea of differential relative automaticity; that is, processing that is 'more' automatic occurs faster than 'less' automatic processing. The assumption made in previous experiments was that processing of the target and distracter stimuli proceeds automatically and at the same rate. It is possible however that processing of highly salient icons , such as flags, is more highly automized than processing the occupation icons. Support for this suggestion comes from MacLeod and Dunbar (1988) who found that initial patterns of interference between certain stimuli could be reversed as a result of training. Such an explanation is consistent with the findings (in Experiment 3.1) which used nationality distractors (British and American flags) and occupation distractors (musical staves and film reels). When the flag icons were used the nationality of the flag clearly modulated a nationality decision to the target face (831ms when the flag was congruent, 876ms when the flag was incongruent). However the occupation icons did not modulate an occupation decision to the face (804ms when the occupation icon was congurent, 801ms when it was incongruent). In fact, for these occupation decisions, an incongruent occupation icon produced less interference than both flags (843 for congruent flag, 853 for incongruent flag). The fact the occupation words (in experiment 3.2) do modulate the occupation decision to a face (in a manner very similar to that found for the flag icons) is again consistent with this idea, as there is no reason to suppose that the distractor words are processed differentially in terms of relative automaticity.

Notwithstanding the above interpretation an overarching assumption in Chapters 2 and 3 was that activation at the level of the SIUs would be at the heart of any semantic priming or interference effects that were found. In light of the above results, it must be acknowledged that this assumption may be wrong. If the locus of these effects is not at the level of the SIUs, then it is hardly surprising that a set of experiments designed to probe the system at this level failed to detect the predicted effects. In fact, if the assumption is wrong then the predictions based on this assumption become untenable.

In light of this possibility, the following Chapter will take a step backwards and attempt to build on Experiment 2.1, which successfully showed semantic priming on to a semantic decision for the first time. Establishing the true locus of this semantic priming effect may allow us to better understand the inconsistency in the semantic priming and interference effects reported above.

# CHAPTER FOUR

*The Locus of Semantic Priming Effects*

## OVERVIEW

This chapter will attempt to build on the success of experiment 2.1, which showed semantic priming on to a semantic decision for the first time. Based on this result and on the previous simulations, the assumption was made that the semantic priming effect was mediated by activation levels within the SIU pool. However, the results from Experiments 2.2, 2.3, 3.1 and 3.2 have called this assumption into question. Failure to find the expected priming and interference effects in these experiments may mean that this assumption is wrong. This chapter will attempt to determine the true locus of this effect by systematically comparing familiarity decisions and semantic decisions in a semantic priming paradigm. It has already been established that above resting levels of activation at the level of the PINs mediates priming on to a familiarity decision. So, by observing the pattern of interaction between the decision types (familiarity and semantic) and different prime types (i.e, associated, familiar and unfamiliar), it should be possible to illuminate the true nature of the semantic priming effect. For instance, one might expect an interaction between decision type and prime type if semantic priming is indeed mediated by SIU activation. On the other hand, if SIU activation levels are not implicated in this effect then one might expect to see no interaction between these conditions.

## EXPERIMENT 4.1

### Introduction

In this first experiment, we replicate Experiment 2.1, and add a new condition. We use the design normally used to demonstrate priming with a familiarity decision, and add conditions in which subjects are asked to make a semantic decision about the target (in this case whether the person is British or American). We anticipate that using a familiarity judgement, we will replicate the standard pattern of semantic priming (e.g., as reported by Young, et al., 1994). Items primed by a associated person (e.g. John Lennon preceded by Paul McCartney) will be judged familiar faster than items primed by an unrelated person (e.g., John Lennon preceded by Bill Clinton), or by a neutral (i.e., unfamiliar) person (John Lennon preceded by Jim Nolan), and that these last two conditions will not differ. Posner and Snyder (1975) distinguished automatic (associated < neutral = unrelated) from strategic (associated < neutral < unrelated) patterns of priming, the pattern anticipated in the current clearly fits the 'automatic' description.

As discussed earlier, the IAC model predicts semantic priming onto a semantic decision. Therefore, in this experiment, a similar pattern of responding might be expected across the semantic decision conditions, as has previously been reported for familiarity decisions.

This experiment uses name stimuli, as both primes and targets. In later experiments face stimuli are introduced.

## Method

### *Participants*

Eighteen undergraduate students from the University of Glasgow participated in the experiment in return for a small payment. In order to ensure that participants were familiar with the critical items, anyone scoring less than 75% correct in any cell of the design was replaced, and this criterion was applied to all subsequent experiments in this Chapter.

### *Materials*

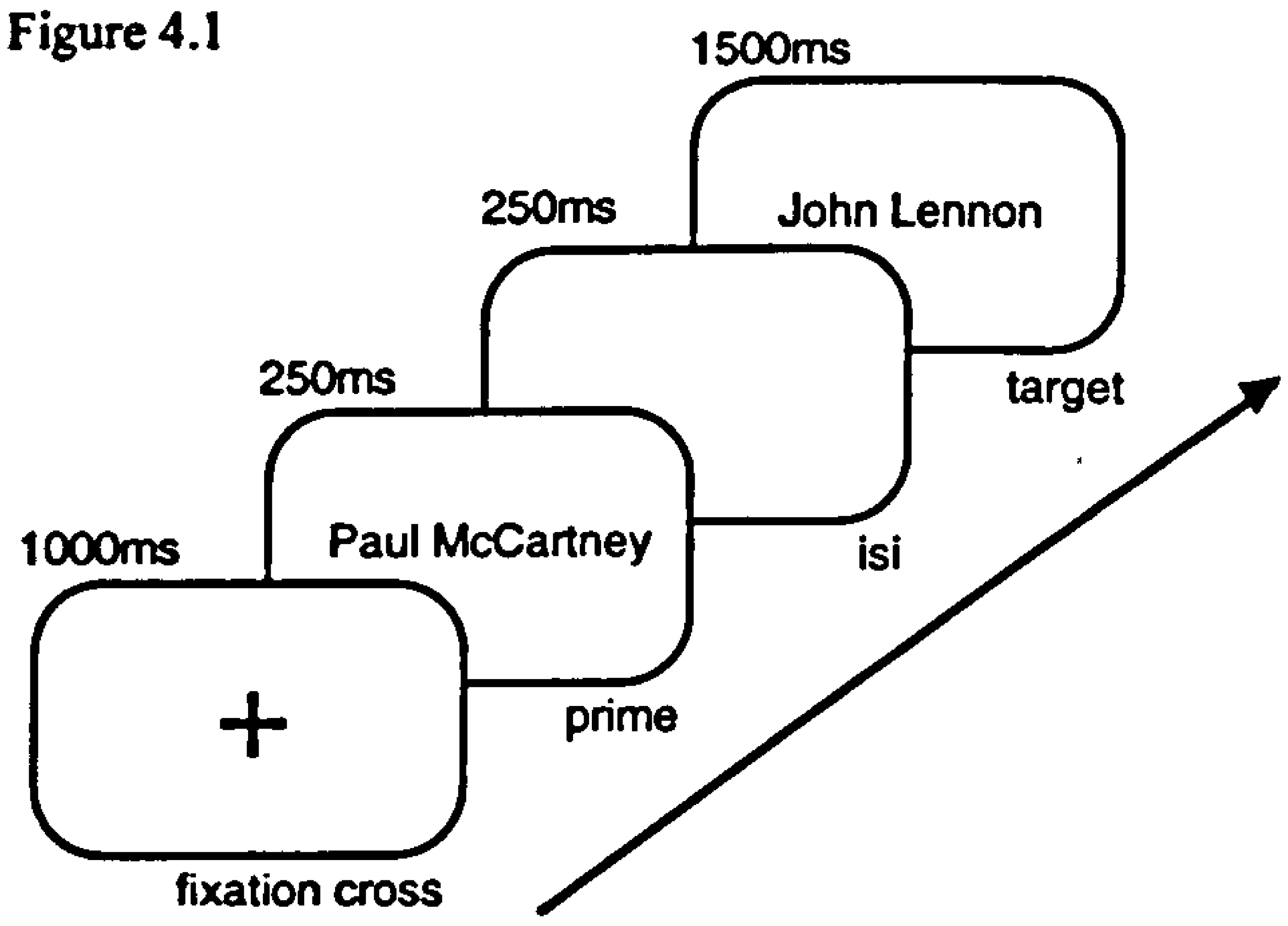
The critical experimental stimuli were the names of 72 famous people organised into three lists of twelve associated pairs (see, Appendix 5). Each list of 12 pairs contained six British and six American name pairs. These lists, combined with a further list of twelve unfamiliar names, were manipulated to construct familiar targets for associated, familiar (but unrelated) and neutral primes. This manipulation resulted in three separate stimulus sets in which target items were fully counterbalanced across the three separate prime conditions. Examples of prime/target stimuli for each condition are as follows: associated condition, Paul McCartney / John Lennon; familiar condition, Tony Blair / John Lennon; unfamiliar condition, Jim Nolan / Prince Charles. The same stimuli were used in both the familiarity judgement and semantic judgement conditions. In order to provide unfamiliar target names for the familiarity judgement condition a further list of 36 unfamiliar names was constructed. These unfamiliar name targets were paired with 36 famous prime names mirroring the nationality pattern described above. All name stimuli were presented centrally, in a sans serif font at point size 36, on a computer monitor at a distance of 50cm.

*Design and Procedure*

The experiment comprised two within-subjects factors: judgement type with two levels (familiarity judgement and semantic judgement), and prime type with three levels (associated, familiar-unrelated and unfamiliar).

Each trial started with a fixation cross, which remained on screen for 1000ms. This was followed by the prime stimulus for a duration of 250ms, followed by an ISI of 250ms, followed by the target stimulus for 1500ms (see Figure 4.1). Subjects were instructed to respond quickly and accurately to the second name in this sequence. In the familiarity judgement condition, they were asked to indicate whether the second name was familiar or unfamiliar. In the semantic judgement condition, they were asked to indicate whether the second name was British or American. In both cases subjects responded by pressing one of two buttons on a computer keypad and response latencies, for both decisions, were measured from the onset of the target stimuli.

Figure 4.1




In total there were 72 trials in the familiarity judgement condition (half of these trials contained unfamiliar targets, from which the data were discarded) and 36 in the semantic judgement condition. All trials were presented in a random order within each judgement type block, with block order counterbalanced across subjects.

## Results

In this and all subsequent experiments latencies over two seconds were discarded, as were outliers exceeding the participant mean by two standard deviations, for any particular condition. This led to 7.9% of the data being excluded overall. Table 4.1. shows the mean correct RTs and error rates for the different

**TABLE 4.1**
Mean RT Data for Correct Decisions
in Experiment 4.1

| | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|
| *familiarity judgemnet* | | | |
| associate | 558 | 81 | 4.2 |
| familiar | 646 | 100 | 6.0 |
| unfamiliar | 641 | 85 | 10.6 |
| *semantic judgemnet* | | | |
| associate | 730 | 128 | 7.4 |
| familiar | 794 | 105 | 8.8 |
| unfamiliar | 804 | 83 | 10.2 |

conditions. The RT data were analysed using a 2 (familiarity vs semantic judgement) x 3 (associated vs familiar vs neutral prime) analysis of variance. The main effect of judgement type was significant, $F(1,17) = 52.97, p < 0.05$, as was the main effect of prime type, $F(2,34) = 25.76, p < 0.05$. There was no judgement type x prime type interaction, $F(2,34) < 1$. For the main effect of prime type, a Tukey HSD test revealed differences between the following conditions: associated prime/familiar prime; and associated prime/unfamiliar prime ($p < 0.05$). The same test revealed no differences between familiar prime/unfamiliar prime conditions.

## Discussion

The results, using a familiarity decision, show reliable facilitation for associated primes as compared to familiar unrelated primes, which themselves do not differ from unfamiliar primes. These results are entirely consistent with the literature on associative priming. While slower overall, the semantic judgement task shows an exactly similar pattern of results. The comparative slowness in this condition is consistent with the processing time course outlined in Chapter 1. That is, familiarity decisions are always faster than semantic decisions. The non-significant interaction for judgement type shows quite clearly that the pattern of responding for the two tasks is equivalent. In conjunction with the results from Experiment 2.1, we take this to be good early evidence that semantic priming can be observed using a semantic judgement. Importantly, it appears that the same mechanisms underlie this priming, as underlie priming in the traditional familiarity decision task. However, before drawing this strong conclusion, it is necessary to explore the effect more thoroughly, and this is done in the following experiments.

## EXPERIMENT 4.2

### Introduction

In this experiment, Experiment 4.1 is replicated, this time using face stimuli instead of names. It is a well-established property of semantic priming that the same pattern of results can be observed using either type of stimuli, and this is accommodated in structural models by proposing that the effect relies on processes which follow convergence of recognition routes for names and faces. A clear prediction from this style of theorising is that the same pattern will hold for faces, in this experiment, as was found in Experiment 4.1 for names. As in Experiment 4.1, we examine priming for both familiarity and semantic decisions within the same study.

### Method

#### *Participants*

Twenty-four undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

#### *Materials*

The critical experimental stimuli were the faces of 48 famous people organised into three lists of eight associated pairs (see Appendix 6). Each set of eight pairs contained four British and four American pairs. These three sets, combined with a further set of eight unfamiliar faces, were manipulated to construct familiar targets for associated, familiar (but unrelated) and unfamiliar primes. This manipulation resulted in three separate stimulus sets in which target items were fully counterbalanced across the three separate prime conditions. These stimuli were used in both the familiarity judgement and semantic judgement conditions. In order to provide unfamiliar target faces for the familiarity judgement condition, images of a further set of 24 unfamiliar faces were taken from a database of photographic portraits. These unfamiliar targets were paired with famous primes mirroring the nationality divisions described above.

All face images were edited to remove background material and clothing, leaving only the face and hair. Images were standardised to have height 6cm, and were then pasted centrally onto an 8cm square grey background. The stimuli were viewed on a computer monitor at a distance of 50cm.

*Design and Procedure*

The design and procedure for this experiment was the same as for Experiment 4.1, except that face stimuli were used instead of names. Examples of stimuli are show in Figure 4.2.

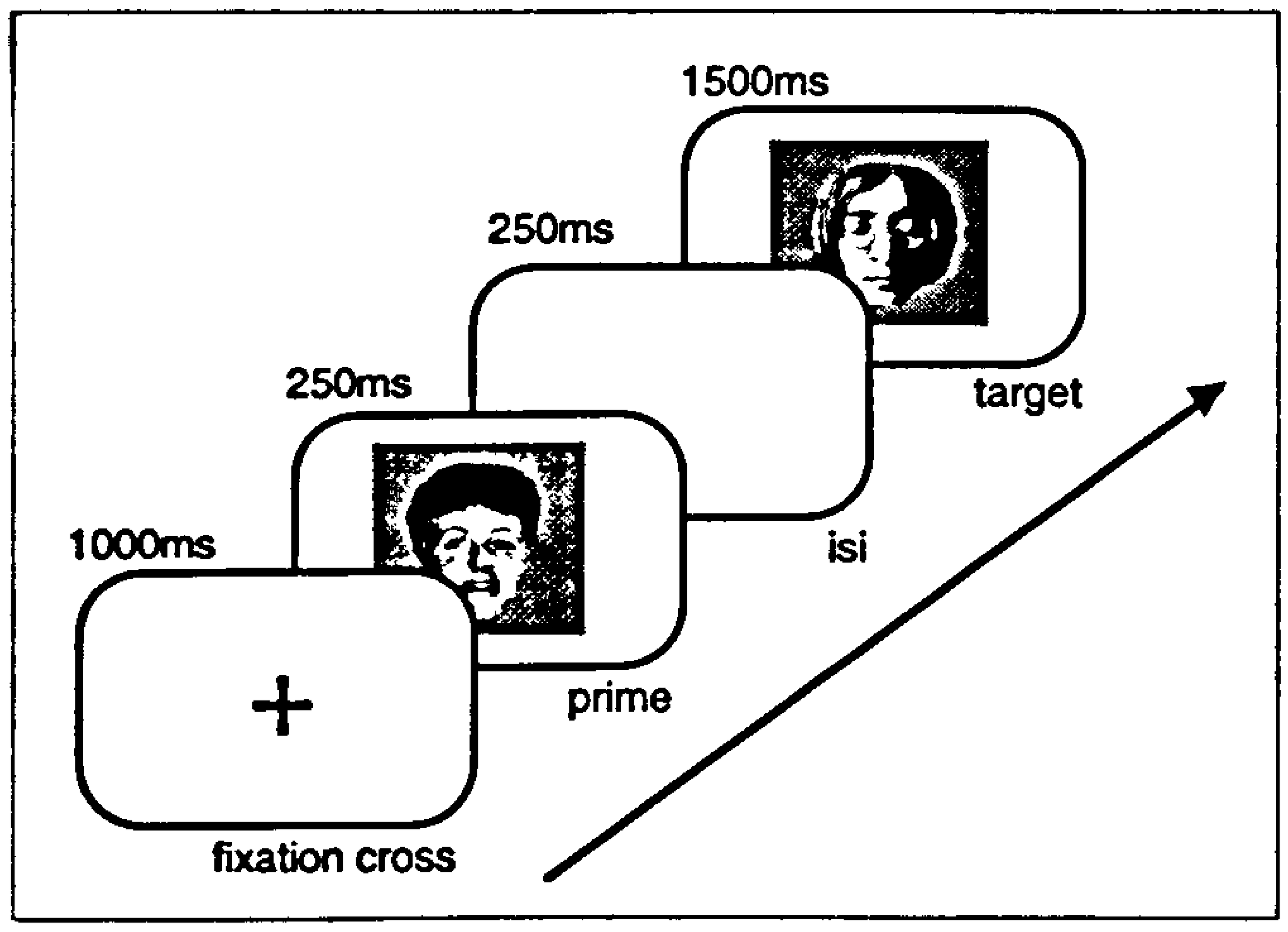



Figure 4.2

## Results

Table 4.2 shows the mean correct RTs and error rates for the different conditions. The criteria for errors was the same as in Experiment 1, and this led to 12.8% of the data being excluded. The RT data were analysed using a 2 (familiarity vs semantic judgement) x 3 (associated vs familiar vs unfamiliar prime) ANOVA. The main effect of judgement type was significant, $F(1,23) = 44.05, p < 0.05$, as was the main effect of prime type, $F(2,46) = 14.51, p < 0.05$. There was no interaction between the two factors, $F(2,46) < 1$. For the main effect of prime type, a Tukey HSD test revealed differences between the following conditions: associated prime/familiar prime; and associated prime/unfamiliar prime ($p < 0.05$). The same test revealed no differences between familiar prime/unfamiliar prime conditions.

**TABLE 4.2**
Mean RT Data for Correct Decisions
in Experiment 4.2

| | | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
| *familiarity judgemnet* | | | | |
| | associate | 683 | 123 | 12.0 |
| | familiar | 767 | 132 | 14.6 |
| | unfamiliar | 755 | 141 | 16.7 |
| *semantic judgemnet* | | | | |
| | associate | 824 | 141 | 6.8 |
| | familiar | 907 | 150 | 12.0 |
| | unfamiliar | 919 | 118 | 15.1 |

## Discussion

The results here show a clear semantic priming effect, with facilitation in the associated condition as compared to the unrelated and neutral prime conditions, which themselves do not differ. As with Experiment 4.1, the pattern of priming is identical regardless of whether subjects make a familiarity or a semantic judgement. The semantic judgements are reliably slower than familiarity judgements, and this is again consistent with Experiment 4.1.

The results from Experiments 4.1 and 4.2 could relatively simply be accommodated either by a structural or an episodic account of semantic priming. As discussed earlier, an IAC account necessarily requires activation of semantic properties for semantic priming to occur. Similarly, co-occurrence theories might easily predict that people seen together share some semantic properties, and so evidence of facilitation can be observed when probing these properties.

A fuller discussion of these issues will be postponed until the general discussion section of this chapter. However, consideration of the shared semantic properties of people who co-occur highlights a potential confound in Experiments 4.1 and 4.2. In both experiments subjects were required that make nationality decisions to familiar people, preceded by an associate, an unrelated familiar person, or a neutral person. The nature of this particular decision is that related pairs of people are likely to share the same nationality, and indeed all pairs in these experiments do so. Although subjects are not required to make a nationality decision to the prime face, it is possible that they could use this compatibility to make the subsequent decision to the prime. For this reason, all primes and targets in the familiar unrelated conditions in Experiments 4.1 and 4.2 were constructed to be compatible in respect of nationality. So, all familiar targets were preceded by a prime of the same nationality, whether related or not. This makes for a fair comparison between associated and unrelated conditions. However, it makes it difficult to argue that unrelated familiar items behave in the same way as neutral items in these experiments, because it is not possible to assign a nationality to the neutral items. In the following experiments, we split the unrelated condition into two sub-conditions, such that the nationality of the primes can be either compatible or incompatible with the targets.

## EXPERIMENT 4.3

This experiment uses name stimuli, at prime and test, and is very similar to Experiment 4.1. The difference is that a second, unrelated-familiar prime type, condition has been added in order to investigate possible effects of compatibility between prime and target. In this additional familiar condition, prime/target pairs are of different nationalities. It is predicted that, as in previous experiments, there will be a facilitation-dominant effect of the associated prime. Further, if the effect observed in Experiments 4.1 and 4.2 is due to the general relatedness of the prime and target items, then no difference should be observed between the unfamiliar-same-nationality, unfamiliar-different-nationality and neutral conditions in this experiment. However, if the effect is based on response compatibility (i.e., same nationality) then a difference might be expected between these three conditions, with faster responding in the unfamiliar-same-nationality condition.

## Method

### *Participants*

Thirty-two undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

### *Materials*

The critical stimuli were sixteen pairs of closely associated people, who were well known to the student population at the time of the experiment. The names of these people were organised into four separate lists of eight associated pairs (see Appendix 7) such that each member of each pair appeared as both prime and target items on different occasions. Each list of eight pairs contained four British and four American pairs. These lists, combined with a further list of eight unfamiliar names, were manipulated to construct familiar targets for: related, unrelated-same-nationality, unrelated-different-nationality, and neutral primes. This manipulation resulted in four separate stimulus sets in which target items were fully counterbalanced across the four prime conditions. The stimuli were used in both the familiarity judgement and semantic judgement conditions. In order to provide unfamiliar target names, for the familiarity judgement condition, a further list of 32 unfamiliar names was constructed. These unfamiliar name targets were paired with primes (including 24 famous names and 8 unfamiliar names) from another list, mirroring the nationality pattern described above. The viewing conditions ere the same as in Experiment 4.1.

*Design and Procedure*

The experiment had two within-subjects factors: judgement type with two levels (familiarity vs semantic judgement); and prime type, with four levels (associated, unrelated-same-nationality, unrelated-different-nationality and neutral primes).

In total there were 72 trials in the familiarity judgement condition (half of which contained unfamiliar targets) and 36 in the semantic judgement condition. The critical stimulus sets were identical for familiarity and semantic decisions and were fully rotated around the prime type conditions, between subjects. All trials were presented in a random order within each judgement type block, with block order counterbalanced across subjects.

Stimulus presentation and experimental procedures were the same as in Experiments 4.1 and 4.2.

## Results

Table 4.3. shows the mean correct RTs and error rates for the different conditions. In this experiment, and in the subsequent experiments in this Chapter, latencies over two seconds were discarded, as were outliers exceeding the participant

mean by two standard deviations, for any particular condition. This led to 2.9% of the raw data being excluded. Incorrect responses accounted for a further 8.3% of the total data. These error rates were analysed using a 2 (familiarity vs semantic judgement) x 4 (related vs unrelated-same-nationality vs unrelated-different-nationality vs neutral prime) ANOVA, which showed that the error pattern did not differ between the experimental conditions: main effect of judgement type, $F(1,31) < 1$; main effect of prime type, $F(3,93) < 1$; judgement type x prime type interaction, $F(3,93) = 1.62$, $p > 0.1$.

RT data were analysed using a 2 (familiarity vs semantic judgement) x 4 (related vs unrelated-same-nationality vs unrelated-different-nationality vs neutral prime) ANOVA. The main effect of judgement type was significant, $F(1,31) = 75.53$, $p < 0.05$, as was the main effect of prime type, $F(3,93) = 7.41$, $p < 0.05$. The judgement type x prime type interaction was non significant $F(3,93) < 1$. For the main effect of prime type, a Tukey HSD test ($p < 0.05$) revealed differences between the related prime condition and each of the other three conditions. No other differences were significant.

**TABLE 4.3**
Mean RT Data for Correct Decisions
in Experiment 4.3

| | *prime type* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
| *familiarity judgement* | | | | |
| | associate | 681 | 108 | 6.0 |
| | familiar-same-nationality | 730 | 115 | 11.7 |
| | familiar-different-nationality | 735 | 121 | 7.7 |
| | unfamiliar | 731 | 125 | 7.7 |
| *semantic judgement* | | | | |
| | associate | 844 | 129 | 8.5 |
| | familiar-same-nationality | 900 | 133 | 8.5 |
| | familiar-different-nationality | 907 | 151 | 8.5 |
| | unfamiliar | 894 | 135 | 8.1 |

*(Unfamilair targets: mean RT, 916ms; error rate, 8.6%)*

## Discussion

The results here confirm the priming effects found in Experiments 4.1 and 4.2. For both familiarity and semantic decisions, associated primes give an advantage over unrelated or neutral primes, and none of these differ. Once again, while slower overall, the semantic judgement leads to exactly the same pattern of RTs as is normally found for a familiarity judgement. The non-significant interaction for judgement type confirms that the pattern of responding for the two tasks is equivalent.

Most importantly, there is no difference between responses to *unrelated-same-nationality* primes and *unrelated-different-nationality* primes, suggesting that the effects observed here are based on the relatedness of primes and targets, rather than on response compatibility.

## EXPERIMENT 4.4

### Introduction

In this experiment, we replicate Experiment 4.3 using face stimuli instead of names. The data already reported in this chapter suggest that the pattern of responding in the current experiment, using face stimuli, should be equivalent to the pattern found in Experiment 4.3, which used names. That is, there will be a facilitation-dominant priming effect of the associated prime and no differences between the other conditions.

### Method

*Participants*

Twenty-four undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

*Materials*

The critical experimental stimuli were sets of faces constructed from the same lists as were used in Experiment 4.3, although some minor changes were made due to the availability of suitable face images of certain familiar people (see Appendix 8). The method used to construct the critical stimulus sets was exactly the same as that used in Experiment 4.3. The stimulus sets for unfamiliar judgements, in the familiarity judgement condition, were prepared in the same way as in Experiment 4.3, this time using faces instead of names. Stimulus preparation and presentation were the same as in Experiment 4.2.

*Design and Procedure*

The design and procedure for this experiment was the same as for Experiment 4.3, except that faces were used instead of names.

## Results

Table 4.4 shows the mean correct RTs and error rates for the different conditions. Using the same outlier criteria as Experiment 3, 2.1% of the data were excluded from the analysis. Incorrect responses accounted for a further 9.0% of the total data. These error rates were analysed using a 2 (familiarity vs semantic judgement) x 4 (related vs unrelated-same-nationality vs unrelated-different-nationality vs neutral prime) ANOVA, which showed that the error pattern did not differ between the experimental conditions: main effect of judgement type, F(1,23) = 1.88, $p > 0.1$; main effect of prime type, F(3,69) = 2.01, $p > 0.1$; judgement type x prime type interaction, F(3,69) < 1.

**TABLE 4.4**
Mean RT Data for Correct Decisions
in Experiment 4.4

| | *prime type* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|---|
| *familiarity judgement* | | | | |
| | associate | 670 | 112 | 7.8 |
| | familiar-same-nationality | 719 | 119 | 6.3 |
| | familiar-different-nationality | 737 | 147 | 9.4 |
| | unfamiliar | 741 | 147 | 9.4 |
| *semantic judgement* | | | | |
| | associate | 793 | 129 | 7.8 |
| | familiar-same-nationality | 865 | 156 | 8.3 |
| | familiar-different-nationality | 841 | 135 | 14.1 |
| | unfamiliar | 832 | 162 | 9.4 |

*(Unfamilair targets: mean RT, 887ms; error rate, 11.1%)*

RT data were analysed using a 2 (familiarity vs semantic judgement) x 4 (related vs unrelated-same-nationality vs unrelated-different-nationality vs neutral prime) ANOVA. The main effect of judgement type was significant, $F(1,23) = 28.97$, $p < 0.05$, as was the main effect of prime type, $F(3,69) = 5.58$, $p < 0.05$. The judgement type x prime type interaction was non significant F(3,69)=1.88, $p > 0.05$. For the main effect of prime type, a Tukey HSD test (p < 0.05) revealed differences between the related prime condition and each of the other three conditions. No other differences were significant.

## Discussion

The results here are very similar to those reported in Experiment 4.3, once again showing a clear semantic priming effect for close associates when a semantic judgement is called for. There is reliable facilitation in the associated condition as compared to all the remaining three conditions, which themselves do not differ. Familiarity judgements are again reliably faster than the semantic judgements, but the non-significant interaction demonstrates that the pattern of responding is the same for both judgement types.

Again, there is no difference between responses to unrelated-same-nationality primes and unrelated-different-nationality primes. This supports the conclusion drawn in Experiment 4.3 that the effects observed here are based on the relatedness of primes and targets, rather than on response compatibility.

A fuller discussion of the implications of Experiments 4.1 to 4.4 will be presented in the General Discussion, but before doing so a final experiment is conducted, in which subjects are asked to make a different decision at test. Sex judgements have commonly been used in studies of face recognition, and current theoretical views hold that judgement of sex takes place in parallel to judgements of familiarity (Bruce, Ellis, Gibling, & Young, 1987). Sex judgements have previously been found not to give rise either to repetition priming (e.g., Ellis et al., 1990) or to semantic priming (Young et al., 1994) . Structural theories of person recognition generally accommodate these findings by suggesting that priming takes place in the system responsible for processing a person's identity, and not in the system processing other facets such as the sex or expression of a face. By these accounts, priming onto a sex judgement would not be expected in the types of experimental designs used in this chapter. However, since we have found exactly the same pattern of priming for two rather different decisions (familiarity and nationality), across four different experiments, and across names and faces, it is necessary to establish whether the effects reported here hold for *any* decision participants might make about a person in this type of design.

## EXPERIMENT 4.5

### Introduction

In the final experiment in this Chapter, we ask subjects to make sex decisions to target stimuli. Our aim is to establish whether personal association gives rise to facilitation of any judgement, or whether, as in previously published research, the same items which provide priming on one type of decision fail to show priming using a different type of decision. As no difference was found between RTs to items primed by unrelated-same-nationality and unrelated-different-nationality conditions in either Experiments 4.3 or 4.4, these separate conditions are collapsed into one unrelated-prime condition for this experiment.

## Method

### *Participants*

Twenty-four undergraduate students from the University of Glasgow participated in the experiment in return for a small payment.

### *Materials*

The critical stimuli were the faces of eighteen pairs of closely associated people, who were well known to the student population at the time of the experiment. Many of these stimulus pairs were identical to those used in Experiment 4.4. These pairings always comprised one female and one male. These people were organised into three separate lists of twelve associated pairs (see Appendix 9) such that each member of each pair appeared as both prime and target items on different occasions. These lists, combined with a further list of twelve unfamiliar faces, were manipulated to construct familiar targets for related, unrelated, and neutral primes. This manipulation resulted in three separate stimulus sets in which target items were fully counterbalanced across the three prime conditions. Equal numbers of male/male and female/female filler items were added to the stimulus sets, making it impossible to predict the sex of the target from the sex of the prime. Stimulus preparation and viewing conditions were identical to previous experiments.

*Design and Procedure*

A single factor within subjects design was used, with three levels (associated, unrelated and neutral prime types). Stimulus presentation and experimental procedures were the same as in the previous experiments. The only difference was that a sex decision (male/female) was required to the target stimuli. Items were fully rotated around conditions.

## Results

Sex decisions are very easy for subjects, and only 0.35% of responses were excluded by the usual outlier criteria. Incorrect responses accounted for a further 2.6% of the total data and did not give rise to any significant differences between conditions, $F(2,46) < 1$. Table 1.5 shows the mean correct RTs and error rate by condition. A single factor ANOVA showed no significant effect of prime type, $F(2,46) = 1.53$, $p > 0.2$.

TABLE 4.5
Mean RT Data for Correct Sex Decisions
in Experiment 4.5

| *prime type* | *mean RT* | *SD* | *error rate (%)* |
|---|---|---|---|
| associate | 612 | 86 | 2.6 |
| familiar | 625 | 75 | 3.6 |
| unfamiliar | 608 | 69 | 2.6 |

## Discussion

There is no evidence of priming using the sex decision. Although one should be careful not to argue that the null hypothesis has been proven, it is certainly the case that we have failed to show priming in an experimental context where it was observed using different decisions (Experiments 4.1 to 4.4). These results show that semantic relatedness does not produce priming for any arbitrary decision. Instead, it seems to rely on decisions that require the perceiver uniquely to identify the person shown. Both familiarity and semantic judgements, of the type used in Experiments 4.1 to 4.4, require access to processes underlying identity, and it is in these circumstances that priming is evident. A judgement that can be made without accessing personal information (and which can easily be made for unfamiliar faces) shows no priming.

## General Discussion

The experiments in this Chapter show the following: First, semantic priming has been demonstrated, for the first time, using a semantic decision to target items; Second, the pattern of this semantic priming is identical to priming normally observed with a familiarity decision, and this pattern is the same regardless of whether subjects make decisions to name or face stimuli; Third, this pattern does not hold for any arbitrary decision, because it is not observed when using a sex decision with the same design and similar items.

As we described in the Introduction, the IAC model of person recognition (Burton et al., 1990, 1999), rests on the proposal that there is a pool of semantic nodes (so called SIUs) which is accessed after classification of the person as familiar (at the PIN level, see Figure 1). Furthermore, the account of semantic priming relies on the notion that these semantic units are shared between people, so two associated known people (say, Paul McCartney & John Lennon) share in common units representing "musician", "Beatle" and so forth. Highly associated people will share many units, and so activation spreading along connecting links will cause some activation to accumulate in the PIN of a close associate of a recognised person.

This architecture necessarily implies that evidence of semantic priming should be observed in the semantic system itself. Since semantic priming is held to rest on activation in this system, it should be possible to observe it by asking subjects to make semantic decisions. Furthermore, evidence of semantic priming should be observable for an arbitrary semantic decision, since activation is held to flow from a PIN to all connected SIUs. In these experiments we have used a nationality decision, but note that it is not the nationality of the stimuli which links together the associated people. We know that both John Lennon and Paul McCartney are British, but it is not only their nationality which links them, rather the many attributes they share in common. Furthermore, the priming seems to rely on the close association of two people (putatively through sharing *many* SIUs), rather than on them sharing just the same nationality. In Experiments 4.1 and 4.2, there was no RT difference between items primed by unrelated familiar items with the same or different nationalities. This strongly suggests that the effects observed here are based on the relatedness of primes and targets, rather than response compatibility.

The evidence presented here is consistent with the IAC account of semantic priming insofar as we have detected evidence of this priming within the semantic system itself. We now explore the theoretical mechanisms that might account for these effects: why does semantic priming occur for semantic decisions? One possible solution would be to propose a mechanism, by which SIUs rise faster to some decision threshold when primed, thus allowing faster semantic decision. The experiments in Chapters 2 and 3 were built on this proposal. However, this solution now seems implausible. In Experiments 4.1 and 4.2, there was a clear difference in reaction time between items primed by a related person and those primed by an unrelated but same nationality person. In both of these cases, the prime item presumably activates a nationality SIU, and this is shared by the target. When the target is shown very shortly afterwards, this nationality SIU is presumably either still active, or only marginally sub-threshold, making it difficult to account for the clear behavioural difference between these two cases.

We propose that the locus of semantic priming observed here is in fact the same locus as proposed for priming onto a familiarity judgement, that is, it is an effect based on sub-threshold activation of PINs for primed items. Consider the task of deciding that a person is British. In order to do this, one must have simultaneously active an SIU ("British") and also a PIN (this person). If the SIU is already active, the decision still cannot be made until the relevant PIN crosses the familiarity threshold. So, if we see Paul MacCartney's face, his PIN and SIUs become active, and this causes some activation in John Lennon's PIN. When Lennon's face is presented, his PIN will reach familiarity threshold faster than normal (i.e. had he been preceded by someone who does not share many SIUs), and so the ability to make the judgement that his PIN and the "British" SIU are simultaneously active will be speeded.

This proposal is completely consistent with previous work suggesting a single locus for semantic priming. Young et al. (1994) showed the same advantage for semantic priming regardless of whether the task was familiarity or naming. The authors argued that this implies a common locus of priming, and proposed that PIN level is the most consistent theoretical proposal. We concur with this conclusion, and believe it can be recruited easily to fit the data here. Of course, there are problems which this account cannot address. First, why is a semantic decision slower than a familiarity judgement, if it is at heart reliant on rising activation in the PINs? Although we have not spelled out a mechanism for establishing that two units (a PIN and an SIU) are simultaneously above threshold it nevertheless seems reasonable that this will require more processing, and hence be slower, than making this decision for a single unit, as in a familiarity decision. Furthermore, our suggestion does not solve the binding problem. If Paul McCartney's PIN is active simultaneously with the "British" SIU, how do we establish that these refer to the same person? In fact, the

IAC architecture allows simultaneous presentation of more than one person, and so SIUs could simultaneously be active that apply to one and only one of the input people. The experiments reported here are certainly not able to resolve such complex issues, and so we must acknowledge them as outstanding. Here we simply note that the explanation is *consistent* with the observed behaviour, and that the model has previously been used to capture interference effects in which more than one person is presented simultaneously (e.g., those reported by Young, Ellis, Flude, McWeeny & Hay, 1986). Such experiments show that when asked to make a semantic categorisation to a person's name, a simultaneously presented face from a competing category slows the decision. This suggests that there is some *cost* to binding a PIN to SIUs when these are in competition. However, the nature of the binding process itself seems unlikely to be captured in a model as simple as the one used here.

We should also consider whether these results have implications for alternative accounts of priming. As we described in Chapter 1, one view of semantic priming is that it relies on the co-occurrence of related items (pairs of people here). This view seems broadly compatible with the more general episodic view of priming advanced by some researchers (e.g., Jacoby & Brooks, 1984; Roediger, Weldon, & Challis, 1989).

It is not straightforward to use a co-occurrence style of account to explain the data presented in this chapter. The semantic property used here (nationality) is presumably not invoked explicitly every time one sees a familiar person. It is therefore not easy to imagine how this could form part of the episode of seeing someone. If one has often seen Lennon and McCartney together, one might naturally expect seeing Lennon to act as a cue for recognising McCartney, but why should it act as a cue for retrieving McCartney's nationality? On the other hand, if people's attributes *all* form part of the episode of seeing them, then it is not clear why some of their characteristics (e.g., their nationality) should give rise to priming, while others (e.g., their sex) do not. For this pattern of results to hold, one needs to make a functional distinction between semantic and sex decisions. Although it would probably be feasible to make such a distinction within an episodic account, this seems to require more theoretical work than is required in appealing to the structural account. This pattern of results was not used to construct models such as IAC, but it nevertheless seems to emerge as a natural consequence of the proposed structure of person recognition.

Of course, major theoretical debates are very unlikely to be settled on the basis of a simple set of experiments such as we have presented here. However, converging evidence for person recognition (e.g., Ellis et al., 1996; Burton et al., 1999) does seem to favour structural over episodic accounts, and the present data appear consistent with this converging evidence. Whatever the eventual resolution of this debate, the data we have presented here constrain future models of person recognition, and will need to be incorporated within them.

# CHAPTER FIVE

*Sex as a semantic decision*

## OVERVIEW

This chapter looks at the normal absence of repetition priming on to sex decisions, in the area of person recognition. Traditionally such decisions are thought to be based on structural type codes, that are processed independently from the type of codes that specify identity information (Ellis et al., 1990). This chapter takes a novel approach to this issue, by forcing participants to treat sex as semantic decision. In the experiments that follow, participants will be forced to use their memory in order to make sex judgements. In all previous experiments in this area, participants have been able to use superficial aspects of the face stimuli to make this type of decision. The proposition here is that when memory is accessed in order to make such decision, repetition priming should be evident.

As discussed in Chapter 1, repetition priming in person recognition is a well-established phenomenon (e.g., Bruce & Valentine, 1985). In a typical experiment, subjects are shown a set of face images and asked to make a judgements about each (e.g., familiar/unfamiliar). Some time later they are shown a further set of faces, some of which appeared in the earlier phase, and again asked to make a decision about each. In this second phase, subjects are faster to respond to those faces which were seen at the prime stage. In this type of experiment, the interval between prime and test phases is normally in the order of minutes, but priming has been shown to last much longer, and persists even when the image or viewing context is changed between prime and test phases (e.g., Bruce, Carson, Burton, & Kelly, 1998).

This is very well researched area, and the characteristics of this effect are relatively uncontentious. For the purposes of this chapter the key findings in the area are as follows:

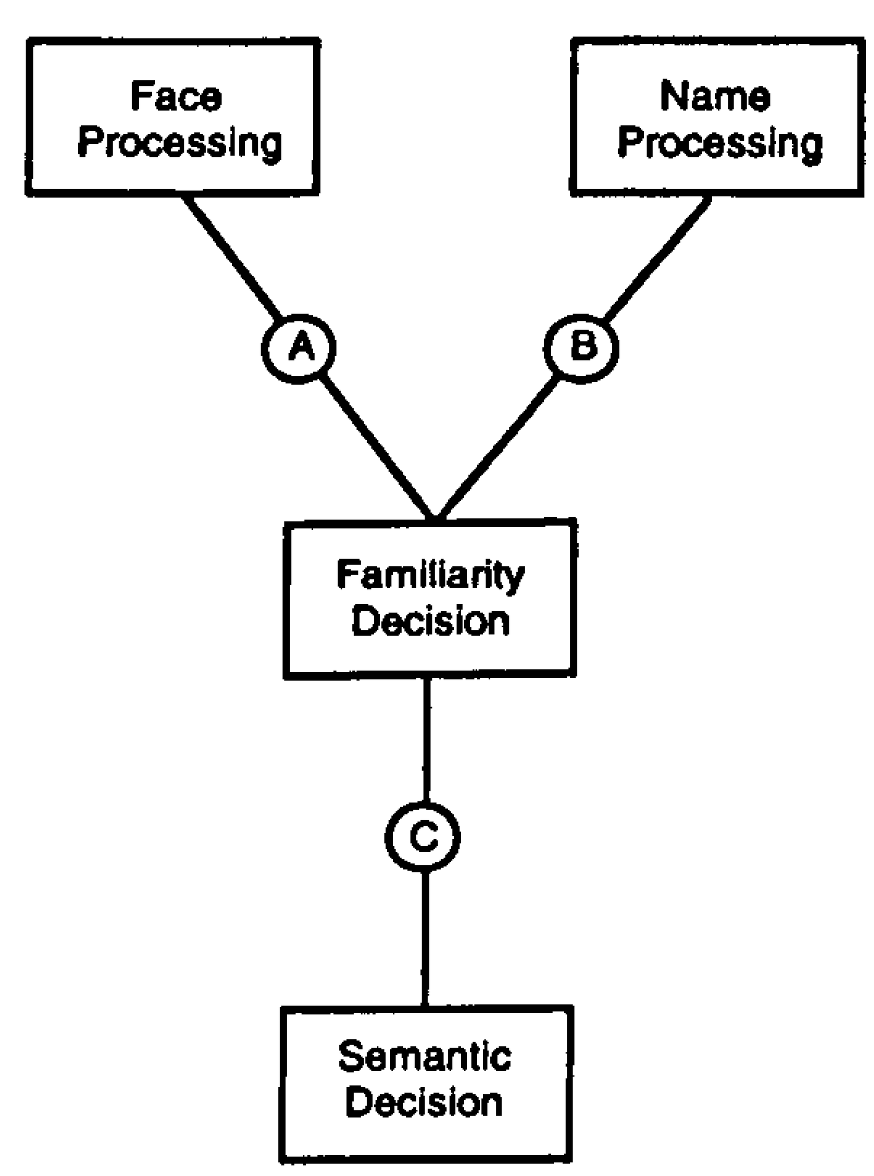
1. Using faces as stimuli, and a familiarity judgement in the test phase, *any* prior decision will produce priming. For example, tasks as diverse as familiarity judgements, nationality judgements, expression judgements and sex judgements, have all been shown to prime a subsequent familiarity judgement to a face (Ellis, Young, & Flude, 1990).
2. Using familiarity judgements at both prime and test phases, the effect does not cross stimulus domains. So, names prime names, and faces prime faces, but they do not prime each other (Bruce & Valentine, 1985; Burton et al., 1998; Ellis et al., 1996).
3. The effect *does* cross stimulus domains when a semantic decision (e.g., British/American) is used at prime and test phases. Furthermore, names and

faces prime one another even when a different semantic decision is used at prime and test phases, for example, dead/alive followed by British/American (Burton et al., 1998).

4. Priming is never observed onto faces when a sex decision is required at test, even when the prime phase task is exactly the same sex judgement (Ellis et al., 1990; though see Goshen-Gottstein & Gannel, 2000, which showed repetition priming effects using part faces).

These results have been interpreted as support for a class of structural models of person recognition, broadly captured in Figure 5.1 (Ellis et al, 1996; Burton et al,

**Figure 5.1.** This figure provides an overview of the implemented model of familiar face recognition (Burton et al.,1990), which was described in detail in Chapter 1.



1998). Repetition priming is held to operate within the system for recognising the identity of a person, and to reflect changes due to repeated use of particular recognition routes. Processes underlying face and name recognition are held to converge at the point where a familiarity judgement is made. Subsequent access to personal information is independent of the route by which the person was recognised. Hence, we would expect recognising a face *as familiar* will strengthen Pathway A (see Fig 5.1), and facilitate subsequent recognition of that face, but not of that person's name (as Pathway B has not been strengthened). However, accessing semantic information about a person requires that Pathway C is used, regardless of whether the person is recognised by face or name, hence the cross-domain priming of semantic judgements. Figure 5.1 captures the essence of this account for the purpose of this chapter, and provides an overview of the implemented model of familiar face recognition which has already been described in Chapter 1. This model has been developing over many years (for details see Bruce & Young, 1986; Burton, Bruce & Johnston, 1990; Burton, Bruce & Hancock, 1999; Young & Burton, 1999).

This class of structural account has been contrasted with episode-based accounts of priming which emphasise the similarity of processing between prime and test phases (e.g., Blaxton, 1989; Jacoby, 1983a). In these accounts, facilitation of processing is optimised by the similarity of stimuli and/or task, between the two phases. Although it is very difficult formally to distinguish between the two classes of account, converging evidence appears to favour structural accounts when considering person recognition. So, for example, it is hard to use an episode-based account to explain why the same decision to the same stimulus can fail to produce priming (e.g., when making a sex judgement to a face at both prime and test), whereas a different decision to a different stimulus can show priming (e.g., British/American to a face, followed by dead/alive to a name).

Here we ask why priming is never observed onto a sex decision. Previous research has suggested that this is because priming occurs within the person recognition system, to which access is not needed in order to judge someone's sex (Ellis et al, 1990, 1996). For example, Bruce et al. (1987) showed that sex judgements are independent of identity judgements, as the speed and accuracy of one process are unaffected by the other. Indeed, we are perfectly accurate in judging a person's sex from a face image, regardless of whether we know them, showing that the decision can be taken on the superficial aspects of the stimulus, rather than relying on access to stored information. The experiments here start with the observation that we can also make a sex judgement from stored information. For example, if exposed to the name "Tyson" (an American boxer, very well known to the participant population at the time of this study), one would have no difficulty determining that the sex of this person is male, based on stored knowledge. So, it seems reasonable that we do store the fact that Mike Tyson is a man along with all the other things we know about him, despite the fact that we can recognise his face as a man's without accessing this knowledge. This gives rise to the following prediction. If we can force subjects to make a sex judgement by accessing their memories, rather than reading the surface characteristics of a stimulus, then we should observe priming. In other words, it will be possible to ask whether sex judgements are themselves somehow special (as evidenced by their apparent immunity to priming), or whether the normal absence of priming simply reflects the locus in the system at which the decision is normally taken.

## EXPERIMENT 5.1

### Introduction

This experiment examines repetition priming of personal information, using a semantic decision (British/American) to a face at prime phase, and a sex decision at test. We used three different types of item in the test phase, though the subjects' task was always a speeded male/female decision. In one condition, we present faces at test. This maximises the similarity of prime/test stimuli, but previous literature (e.g., Ellis et al., 1990) suggests there will be no priming. In a further condition, we present the full names of celebrities (e.g. "Mike Tyson"). Here it is more difficult to make a prediction. Perhaps subjects will be able to use surface characteristics to make the decision, because "Mike" is male name, on the other hand, they could retrieve *male* from their semantic knowledge of this individual. In the final condition we presented surnames only (e.g. "Tyson"). The people selected as stimuli were sufficiently well known to be identifiable, by the target population, by their surname alone (e.g., Tyson, Geldof, Aguillera). In this surname condition, subjects *must* access their semantic store to make the sex decision, because the name alone could equally well refer to a man or a woman.

## Method

### *Participants*

Forty-eight students from the University of Glasgow participated in the experiment in return for a small payment.

### *Stimuli and apparatus*

Experimental stimuli were the names and faces of forty-eight famous people, chosen to be familiar to the participant population. The names and faces were presented centrally on a computer monitor at a distance of 50cm. Names were presented at point size 32. Greyscale face images were edited to remove background material and clothing. These images were standardised to a height of 6cm and were pasted centrally onto an 8cm square grey background. All stimuli were viewed on a computer monitor at a distance of 50cm.

*Design and procedure*

The experiment had one within subjects factor: priming status, with two levels (primed and unprimed), and one between subjects factor: test stimulus type, with three levels (surname, full-name and face). In the first phase of the experiment, subjects were shown the faces of half of the 48 critical items, in a continuous sequence. Each stimulus was presented for 500ms, and participants were asked to make a speeded semantic decision (British/American), by pressing one of two buttons, using the index and middle fingers of their left hand. This was followed by an unrelated task, which lasted for 5 minutes. In the second phase, items from the prime phase were presented again, this time embedded among novel items (i.e., the remaining half of the stimuli). Participants were randomly allocated to one of three groups, to be tested on surnames, full-names or faces. Each stimulus was again presented for 500ms. Participants were asked to make a speeded sex decision (male/female), to all test items, by pressing one of two buttons, using the index finger and thumb of their right hand. Response latencies were measured from the onset of the target stimuli. Trials were presented in a random order for each subject, and the subset of items used in the priming phase was counterbalanced across subjects.

## Results

Median RTs for correct responses were calculated for each subject, and means of these by condition are shown in Table 5.1. Error rates were small overall (5.3%) and did not differ significantly between conditions. The error data were analysed using a 2 (primed vs unprimed) x 3 (surnames vs. full-names vs. faces) mixed analysis of variance. There was no main effect of prime status, $F(1,45) < 1$, and no main effect test stimulus type $F(2,45) = 2.33$, $p > 0.1$ The test stimulus type x prime status interaction was also non significant, $F(2,45) = 1.21$, $p > 0.1$.

**TABLE 5.1**

Mean RTs for sex decisions in Experiment 5.1

| Condition | Unprimed | Primed |
|---|---|---|
| Surnames | 948 | 905 |
| SD | 179 | 153 |
| Full-names | 651 | 645 |
| SD | 104 | 113 |
| Faces | 588 | 585 |
| SD | 90 | 82 |

RT data were analysed using a 2 (primed vs unprimed) x 3 (surnames vs. full-names vs. faces) mixed analysis of variance. The main effect of prime status was significant, $F(1,45) = 6.81$, $p < 0.05$, as was the main effect of test stimulus type, $F(2,45) = 34.87$, $p < 0.05$. These main effects were modified by a significant Priming Status x Test Stimulus Type interaction, $F(2,45) = 3.95$, $p < 0.05$. Analysis of simple main effects showed a significant difference between primed and unprimed items for surnames, ($F(1,45) = 14.4$, $p < 0.05$), but no difference between primed and unprimed items, for either faces or full names ($F(1,45) < 1$ in each case).

## Discussion

This experiment shows that a sex decision to a famous person's surname is facilitated by a previous nationality decision made to a picture of that person's face. To our knowledge, this is the first demonstration of priming onto a sex decision, using the names of familiar people as targets. The effect seems to rely on the fact that subjects must make this decision on the basis of personal knowledge of the targets, and is therefore consistent with the notion that priming has its locus within the system responsible for computing someone's identity. The experiment also replicates previous findings, which show no priming onto sex decisions, when the test items are faces. The absence of priming in the full-name condition is interesting, and is consistent with the idea that decisions in this condition are based on processing the first name only. As the first name defines (by convention) the sex of the person, there is no need to access semantic information related to that person in order to make a decision. These data indicate that sex, accessed as a semantic property, shows the same pattern of repetition priming as any other semantic decision.

## EXPERIMENT 5.2

### Introduction

Episodic theories predict that priming should be maximised when stimuli and processing at prime and test phases are most similar. In this experiment, we examine repetition priming of personal information, using a sex decision to a full-name at prime, and a sex decision to a full-name or a surname at test. Theories emphasising the similarity of prime and test phases might predict maximum priming when stimuli and test are identical (sex decision to full names in both phases). However, results from Experiment 5.1 suggest that sex decisions can be taken on the superficial characteristics of full names, and these do not support priming. Therefore, a structural theory emphasising access to personal information might predict that priming will be maximised when the task at test requires access to personal information (i.e., sex decision to a surname only), even though the task at prime phase is different (sex decision to full name).

## Method

### *Participants*

Thirty-two students from the University of Glasgow participated in the experiment in return for a small payment.

### *Stimuli and apparatus*

Stimuli were the names of the same forty-eight famous people used in Experiment 5.1.

### *Design and procedure*

The experimental procedure was identical to Experiment 5.1, except that at prime phase subjects made a sex decision to a full-name. At test phase, half the subjects made sex decisions to a full-name, and half made sex decisions to surnames. Subjects were allocated to test conditions at random, and the subset of items used in the prime phase was counter-balanced across subjects.

## Results

Median RTs for correct responses were calculated for each subject, and means of these by condition are shown in Table 5.2. The error data were small overall (6.3%) and were analysed using a 2 (primed vs unprimed) x 2 (surnames vs. full-names) mixed analysis of variance. The main effect of prime status was significant, $F(1,30) = 6.19$, $p < 0.05$.The main effect of test stimulus type was non significant, $F(1,30) < 1$, as was the Priming Status x Test Stimulus Type, $F(1,30) = 3.86$, $p > 0.05$. As there was no main effect of test stimulus type and no interaction for these errors, these effects were not analysed further.

**TABLE 5.2**

Mean RTs for sex decisions in Experiment 5.2

| Condition | Unprimed | Primed |
|---|---|---|
| Surnames | 810 | 745 |
| SD | 97 | 96 |
| Full-names | 646 | 625 |
| SD | 100 | 85 |

RT data were analysed using a 2 (primed vs unprimed) x 2 (surnames vs. full-names) mixed analysis of variance. The main effect of prime status was significant, $F(1,30) = 28.56$, $p < 0.05$, as was the main effect of name type, $F(1,30) = 20.06$, $p < 0.05$. These main effects were modified by a significant Prime Status x Name Type, $F(1,30) = 5.96$, $p < 0.05$. Analysis of simple main effects showed a significant difference between primed and unprimed items for surnames, $F(1,30) = 30.31$, $p < 0.05$, and for full-names $F(1,30) = 4.21$, $p = 0.049$.

## Discussion

This experiment shows a large priming effect (65ms) when a sex decision to a famous person's surname is preceded by a previous sex decision made to that person's full-name. In contrast, a sex decision taken on a full-name facilitates the same sex decision to the same full-name to a much smaller extent (21ms). This result is consistent with the idea that priming is a result of changes within the system responsible for computing identity. It appears that requiring subjects to access this route is a more powerful method of inducing priming than is holding prime and test processes constant.

Although small, the significant effect of full-name to full-name priming is interesting for two reasons. First, it demonstrates priming of a very fast response, suggesting that failure to observe priming onto full names in Experiment 5.1 is not due to a floor effect. RTs to full names are similar in both experiments, but while Experiment 5.2 gives significant priming, there is no hint of priming in Experiment 5.1. Second, the full-name to full-name priming does suggest some evidence for episode-based processing in this task. Since this task can be carried out on the surface characteristics of the stimuli (i.e. "Mike" is conventionally male), one does not need to access one's knowledge about the stimulus name. Nevertheless, some priming is observed, and it seems plausible that this reflects processes separate from the person-identity system. An episode-based account of priming is a natural candidate to account for this effect. However, such an account is harder to reconcile with the larger priming effect observed in the surname-only condition, in which stimuli were changed between prime and test phases. Structural accounts seem more naturally to fit that effect.

## General Discussion

In sum, we have demonstrated, for the first time, that sex decisions can show priming on to the names of familiar people. Facilitation is observed onto judgements of sex when subjects are required to take those decisions on the basis of their semantic knowledge about people. In this regard, sex is not somehow a "special" semantic category, but behaves like any other semantic category, which has been studied in the literature. These effects seem to follow naturally from existing structural models of person recognition (e.g., Burton et al, 1990, 1999), although such models were not developed to account for these effects. On the other hand, a simple episode-based theory seems more difficult to reconcile with the whole pattern of results presented here. We have observed some suggestion of an episodically-mediated effect in Experiment 5.2, but it seems difficult to apply this to the remainder of the results. Therefore, parsimony and converging evidence from a number of different experimental investigations currently make structural accounts of person recognition very attractive.

However, recent work by Goshen-Gottstein and Gannel, (2000), has cast doubt on the theoretical plausibility of structural models of the IAC type. These authors advocate a move backward, towards an earlier unimplemented model, such as that proposed by Bruce and Young (1986). In this model, semantic information is accessed via modality-specific FRUs, rather than via the modality-free PINs, as suggested by later models (Burton et al., 1999; Burton et al., 1990). Goshen-Gottstein and Gannel, (2000), based this proposal on a set of five experiments exploring repetition priming of sex decisions.

One measure of the utility of any theoretical framework is the amount of empirical data that it can account for. We have already established that the data reported here (Experiments 5.1 and 5.2) can be readily accommodated within the IAC framework and that an episodic style account of this phenomenon provides a less satisfactory explanation. We now ask, can the framework proposed by Goshen-Gottstein and Gannel (2000) accommodate these findings? In their study, repetition priming was shown on to sex decisions under certain experimental conditions. The crucial manipulation, in this set of experiments, was the removal of the hair from faces in certain conditions, leaving only the internal features. Intelligence judgements to both edited (internal features only) and complete faces, at study, primed subsequent sex decisions to edited faces at test. However, no priming was found on to complete faces at test priming (Goshen-Gottstein and Gannel, 2000, experiments 2 and 3). These authors interpreted these findings by appealing to the truncated-processing hypothesis (e.g., Roediger & McDermott, 1993) which suggests that abstract perceptual records cannot be reactivated unless the repeated stimulus is processed in its entirety, as a perceptual whole.

Goshen-Gottstein and Gannel (2000) propose that participants adopt a hairstyle heuristic when making a sex decision and ignore the internal features of the face. It is claimed that this heuristic can operate at both study and test to mediate priming effects. If it operates at study (when the task is a sex decision to complete face), the internal features are not processed (at least to the required depth) and therefore do not support subsequent priming (Goshen-Gottstein & Gannel, 2000, experiment 3). If participants use this heuristic at test, the internal features do not need to be processed, so it is irrelevant whether or not these features have been primed during the study phase. The argument here is that priming should not occur in this condition, as processing is truncated prior to any advantage, which might accrue from the prior processing episode (Goshen-Gottstein & Gannel, 2000, experiment 2). This truncated-processing hypothesis could feasibly be recruited to fit some of data reported in Experiment 5.1 and Experiment 5.2. However when the data set is considered as whole this type of account proves unsatisfactory.

In Experiment 5.1 a semantic decision (British/ American) is required at study to a face, so there is no obvious heuristic that could be adopted to make this decision. Presumably then, the faces in the study phase are processed in their entirety and should support priming on to an appropriate test task. If Goshen-Gottstien and Gannel (2000) are correct, priming should not be evident when the target item is a face, as participants can use the hair heuristic and need not process the internal features of the face. So this account has little difficulty accommodating the data from Experiment 5.1, when the test stimuli is a face. Again, the lack of priming in the full-name condition can easily accommodated within this framework. If repetition priming of faces is produced by reactivation of domain specific FRUs (as these authors suggest) then there is no reason to presume that presentation of a stimulus in another domain (i.e., a written name) at test should produce priming. Alternatively, it might be argued that the participants simply use a local 'first name' heuristic here, analogous to the 'hair' heuristic described earlier.

However, using their proposition to account for the priming effect on to surnames is more difficult. Following the logic suggested by Goshen-Gottstien and Gannel (2000), one might presume that the surname activates a domain-specific Name Recognition Unit (NRU), in much the same way that a face activates an FRU. According to the memory systems account, which these authors favour, domain-specific perceptual representation systems are modified, by stimulus encounters, which leave perceptual records that facilitate subsequent processing (e.g., Moscovitch, Goshen-Gottstein, & Vriezen, 1993). In order to use this type of theory to account for the priming in the surname condition one would have to argue that a perceptual record stored in a face-specific representation system facilitates processing in a name-specific representation system. On the other hand, IAC style models accommodate cross-domain repetition priming effects in a straightforward way (see, Burton, Bruce & Kelly, 1998).

In Experiment 5.2, a sex decision is required at study, to a full-name, so in terms of the Goshen-Gottstein and Gannel proposal, it could be argued that participants use a 'first name' heuristic to processes this decision. If such a strategy in indeed adopted then this 'truncated processing', at the study phase, should not support subsequent priming on to a sex decision to the same person's surname at test.

The reason for this becomes clear when we examine the locus of these effects, as proposed by these authors. Put simply, their claim is that processing a face in its entirety either produces or modifies an FRU, and reactivation of this FRU is the locus of the repetition priming effect. Following this logic, processing a person's name in its entirety should create or modify an NRU, which may support subsequent priming. However if the name is not processed in its entirety, then an NRU should not be created or modified and priming would not be predicted. If, on the other hand, one assumes that the study name is processed in its entirety, then one should surely expect more priming on to this same full-name than on to a part name (i.e., surname). However, Experiment 5.2 shows a much larger priming effect for surnames over full-names when the study item is a full- name. It is acknowledged that the Goshen-Gottstein and Gannel proposal could account for the small priming effect, for full-name in Experiment 5.2, if this effect is viewed in isolation. However, when viewed alongside the much larger effect for the surname condition this account does not provide an adequate description of the data.

Therefore, having considered alternative explanations, it appears that structural models of the IAC type (Burton et al., 1999; Burton et al., 1990) provide the most parsimonious description of the data reported in these experiments. It is worth noting that this model was not devised specifically to test the predictions generated in the above experiments. In fact, its structure is highly constrained, due to the fact that it has been devised and extended to account for many effects that are well known in the person recognition literature. These include: repetition priming, semantic priming, distinctiveness effects (Burton et al (1990), covert recognition in prosopagnosia (Burton, Young, Bruce, Johnston, and Ellis, 1991), name retrieval (Burton and Bruce, 1991), learning new faces (Burton 1994), cross-domain repetition priming (Burton et al., 1998), and categorial priming (Carson and Burton, 2001). The step backward that Goshen-Gottstein and Gannel (2000, p212) propose may account for the data in their particular study, however, such a model would clearly fail to adequately describe many of the above effects, including those reported in Experiments 5.1 and 5.2.

# CHAPTER SIX

*Summary, Evaluations and Further Research*

## SUMMARY OF MAIN FINDINGS

Chapter 2 attempted to disambiguate the structure of semantic memory by comparing the models of Burton et al. and Brédart et al. using a semantic priming technique. Support here for either model would have allowed future research to focus on the favoured framework. Unfortunately, the data from the experiments in this chapter did not provide unequivocal support for either model.

This chapter began by reporting the results of three new simulations using the Burton et al framework. The first simulation (Figure 2.2) simply predicts that semantic priming should be observed on to a semantic decision. Experiment 2.1 verified this prediction. Using the names of famous people as stimuli, this experiment indicated that it was indeed possible to observe this type of priming. Above resting levels of activation at the level of the SIUs was offered as a parsimonious explanation of this effect.

Experiments 2.2 and 2.3 attempted to build on this finding by introducing an intervening item between the prime and target items. Simulations 2 and 3 (Figures 2.3 and 2.4) predicted that this semantic priming effect should survive an intervening item in certain circumstances. Further, the Burton et al. and Brédart et al. models predicted different outcomes using this intervening item paradigm, and it was hoped that the results here would favour one or other model. Put simply, Burton et al., with its undifferentiated semantics, predicts that an occupation decision intervening between two nationality decisions should eliminate priming, whereas in the Brédart et al. model only nationality decisions should interfere. However, Experiment 2.2, which manipulated the semantic decision required to the intervening item in relation to the semantic decision required to prime and target items, failed to verify even the basic prediction from the simulations, showing no differential priming effects between the various conditions. Of course, these null effects mean that these experiments also failed in their primary objective of discriminating between the models in question. These results appear to show that priming does not survive an intervening item. If this type of priming does not exist, clearly it cannot be recruited to differentiate between the models. However, the trends in the data did offer some support for the basic idea that semantic priming should survive an intervening item.

Using what was thought to be a powerful design, Experiment 2.3 again failed to confirm even the basic prediction from the simulations. Formally the findings here support the conclusion above, and suggest that semantic priming does not survive an intervening item. However, the trends in the data from this experiment were very similar to those found in Experiment 2.2. This similarity suggested that it might be worthwhile to investigate these effects further using a different type of experimental approach.

This new approach was taken in Chapter 3, using an interference paradigm. In Experiment 3.1 participants were asked to make semantic decisions to faces in the presence of semantically congruent or incongruent distractors icons. One perceived benefit of using these icons over the face stimuli used in Experiments in Chapter 2 is that these icons activate essentially only one semantic property, whereas the face stimuli activate all semantic properties associated with that face. The overall pattern of responding in the different conditions of this experiment was, however, again inconsistent and again failed to offer convincing support for either model. A final attempt was made to distinguish between these competing frameworks in Experiment 3.2

This experiment used stimuli very similar to those used by Young et al (1986). This time the participants made semantic decisions to faces in the presence of semantically congruent or incongruent speech bubbles. In Young et al.'s study these speech bubbles contained the names of distractor people. Here words representing the semantic properties under investigation where used (i.e. "film star" / "pop star", "British" / "American"). Again, it was assumed that these words would activate essentially only one semantic property. Once again, however, the data did not provide strong support for either model.

Guided by the failure of Experiments 2.2, 2.3, 3.1 and 3.2, Chapter 4 takes a step backwards and attempts to build on Experiment 2.1 which successfully showed semantic priming on to a semantic decision for the first time. The experiments in Chapter 4 were designed to explore, in more detail, the nature of this effect. This was achieved over the course of five experiments, which systematically compared semantic decisions with other types of decision (i.e., familiarity decisions and sex decisions).

Experiment 4.1 replicates the design of Experiment 2.1 in which participants are asked to make semantic decisions (British/American) to target names which were preceded by the names of by associated, familiar, or unfamiliar people. An important new condition is added, which requires that familiarity decisions be made to the same items. This was done in order that the patterns of responding for both decision types may be compared. The results here showed that, while slower overall, semantic decisions showed exactly the same pattern of responding as familiarity decisions: that is, reliable priming in the associated condition as compared to the familiar unrelated primes, which did not differ from the unfamiliar primes. This provided the first indication that the same mechanism might underlie this priming effect for both familiarity and semantic decisions. It has previously been established that the semantic priming effect for familiarity decisions relies on above resting levels of activation at the PINs (e.g., Burton et al., 1990). The suggestion here is that semantic priming for semantic decisions may share the same locus (this is, of course, inconsistent with the main assumption which underlies the experiments in Chapters 2 and 3).

Experiment 4.2 replicates the findings of Experiment 4.1, but this time using face stimuli instead of names. The results show the same pattern of responding as was observed in Experiment 4.1, thus extending the generality of the conclusion drawn above.

In order to rule out a possible confound of nationality, Experiments 4.3 and 4.4 split the familiar unrelated condition into two sub-conditions. For both name stimuli (Experiment 4.3) and face stimuli (Experiment 4.4), only the associated primes showed reliable facilitation; no difference was found between the familiar-same-nationality and familiar-different-nationality conditions, which did not differ from the neutral condition. These findings effectively ruled out the possible confound of nationality in these experiments, and provides further evidence that activation at the level of the SIUs does not play a significant role in the observed effect. This reinforces the idea that activation at the level of the SIUs is not a primary determiner of the effects that were sought in the experiments in Chapters 2 and 3. These results again point to the PINs as the locus of these effects.

Using face stimuli, Experiment 4.5 found no evidence of priming on to sex decisions, indicating that semantic relatedness alone does not produce priming for any arbitrary decision.

Two important conclusions were drawn from the data in this Chapter. First, when taken as a whole these data appeared to fit structural style accounts better than episodic style accounts. Secondly, when interpreted within a structural framework, such as IAC, these results appear to indicate that the locus of semantic priming effects is at the level of the PINs rather than at the level of the SIUs, as previously suggested in Chapters 2 and 3.

In Chapter 5 participants are forced to treat sex as a semantic decision. This was achieved by using the surnames of famous people at the test phase. Experiment 5.1 shows that a sex decision to a famous person's surname is facilitated by a previous nationality decision to a picture of that person's face. In contrast, no priming was found, in same circumstances, on to either faces or full-names. This is the first demonstration of priming on to a sex decision, using the names of familiar people as targets. Experiment 5.2 shows a large priming effect when a sex decision to a famous person's surname is preceded by a previous sex decision to that person's full-name. However, when the target stimuli was the same full-name, a much smaller priming effect was observed. The data from these experiments were assessed within competing theoretical accounts of person recognition and it was suggested that structural accounts such as IAC provided the most parsimonious description.

## EVALUATION OF MAIN FINDINGS

This thesis began by acknowledging that current models of person recognition inadequately describe the semantic structure of personal information. In Chapters 2 and 3 predictions generated by two models in this area are compared (Burton et al., 1990, and Brédart et al., 1995). The objective here was to find out if semantic information was stored in an undifferentiated way, in one large pool (Burton et al., 1990), or differentially by attribute (e.g., nationality, occupation, etc.), in smaller pools (Brédart et al. 1995). An assumption was made in these experiments that activation, at the level of the SIUs, would mediate any observed priming effects.

However a series of four experiments (Experiments 2.2 , 2.3, 3.1 and 3.2) failed to provide support for either model. In fact, these experiments failed to support the basic idea that priming should survive an intervening item. There are two possibilities that might account for the failure of these experiments. The first has already been discussed in detail in Chapters 2 and 3 and relates to the power of the experimental manipulations within the experiments reported. The second explanation is more profound. It may be that activation at the level of the SIUs is not the primary determinant of these effects.

This possibility was examined in detail in Chapter 4, which indicated that the primary locus of these effects was not at the level of the SIUs, but instead at the level of the PINs. The overall pattern of responding in the experiments in Chapter 4 offers no support for the idea that activation at the level of the SIUs may contribute to these effects. This assertion is based on the following argument. It has already been established that the locus of semantic priming for familiarity decisions is at he level of the PINs (Burton et al., 1990). If activation at the level of the SIUs, contributes to this effect for semantic decisions, then one would expect to see a Decision Type x

Prime Type interaction in experiments that test both types of decision. That is, one would expect to see an additional advantage for same nationality items over different nationality items (or indeed unfamiliar items) when a semantic decision is required, as compared to when a familiarity decision is required. There is no hint of a Decision Type x Prime Type interaction across the four experiments (Experiments, 4.1, 4.2, 4.3, 4.4) reported in Chapter 4. This finding, coupled with the null effects reported in Chapters 2 and 3, suggests that activation at the level of the SIUs is not a primary determinant of these effects. The conclusion that must be drawn here is that the experiments in Chapter 2 and 3 failed because the assumption on which they were built subsequently proved to be incorrect. In light of the proposal that these effects are primarily determined by activation levels at particular PINs, it is hardly surprising that a set of experiments designed to manipulate activation levels at particular SIUs failed to find significant effects.

The finding that these effects are primarily determined by activation at the PINs has important implications for IAC style models in terms of their ability to describe the semantic structure of personal information. The only way to disambiguate what is happening at the semantic level is to probe the system at the level of the SIUs. Such an attempt was made in Chapter 2, which demonstrated the futility of this exercise when face stimuli are used at test. The test face in question must be recognised prior to a semantic decision being made. This of course relies on a particular PIN passing its recognition threshold. Only when this node passes threshold can any advantage from prior activation at the level of the SIUs accrue. However, any potential advantage due to increased activation at a particular SIU is unlikely to be observed, because this same node is being driven upwards via activation from the associated PIN. By the time that the PIN has reached threshold, any advantage of prior activation at a particular SIU will have been lost. This argument applies equally well to previously activated nodes that are not a property of the target person. Such nodes will be driven downwards (via within-pool inhibition) as activation flows from the PIN of the target to the semantic properties that *are* associated with it. This proposal effectively describes the data in Experiments 2.2, 2.3, 4.1, 4.2, 4.3 and 4.4.

In the experiments reported in Chapter 3 the interfering stimuli are presented simultaneously rather than sequentially, but the above arguments also hold for this type of presentation. The person has to recognised before a semantic decision is taken, so the differential effect of increased activation at the node representing the icon property, would be mediated by activation passed from the relevant PIN to its associated SIUs as it rises towards its threshold. This constraint makes it difficult to see how the semantic system (as described by these models) might be effectively probed when face or name stimuli are used at test.

It should therefore be acknowledged that IAC models as currently formulated are unlikely to deliver new insights into how the semantic system is structured. Activation levels at the level of the SIUs can only be assessed after a familiarity decision has been taken. However, in the time that it takes to make this decision, any prior advantage at a particular SIU is likely to have been eliminated.

By definition, the IAC model is a model of familiar person recognition. At present the only way to observe how activation flows in the semantic part of this model is to present a familiar face (or name) and let activation flow in the normal way (FRU > PIN > SIU). However, a familiar face or name will always produce activation at the PINs. It now appears that activation flowing from these PINs (as they rise towards their recognition threshold) to associated SIUs will always swamp previous activation levels at the SIU level, thus eliminating any prior advantage that might exist. It seems then that if we are to observe the effects of prior processing at the level of the SIUs then we must probe this system without activating the PINs. How this might be achieved in a model in which semantics are accessed exclusively via the PINs is unclear.

The primary aim of this thesis was to find new evidence that might help to illuminate the semantic structure of personal information. Little progress has been made in this respect. The experiments reported here bring us little closer to understanding how this information may be structured. What is now perhaps more evident is the difficulty of such an undertaking using the models that are currently available. Of course, one important function of any model is to account for the empirical data in a particular field and the IAC model has continued to perform remarkably well in this respect. All of the data reported in thesis can be explained within this framework. However, perhaps even more importantly, a model should generate new and testable predictions. As currently formulated the IAC model provides access to the semantic system exclusively via the PINs. As activation levels build up at the PIN, activation is passed to associated SIUs. This activation (passing from the PIN to associated SIUs, as the PIN approaches its threshold) effectively eliminates any prior advantage at the SIU level. This means that it any predictions that might be generated by appealing to activation levels within the semantic system itself are untestable. This must be viewed as a major shortcoming of IAC type models in their current form.

Chapter 5 forced participant to process sex as a semantic decision. Using a repetition priming technique, these experiments showed that when sex is accessed as a semantic property it behaves exactly like any other semantic property that has been studied in this area. While perhaps unsurprising, these new data once again offer support for IAC style models. This style of model managed to account for all of the data reported in this experiment. Episodic style theories accounted for some but not all of the data. The recent framework proposed by Goshen-Gottstein and Gannel similarly accounted for some but not all of the data.

In conclusion, all of the new empirical findings reported in this thesis have been readily accommodated within the IAC framework. In fact, the record of this model in terms of accommodating new findings during the last twelve years or so has been very impressive. However, as noted earlier, this positive aspect of this model must be seen in the context of its ability to generate new predictions. An important next step if we are to truly understand the process of person identification is to better understand how personal information might be structured. The experiments in Chapter 4 of this thesis demonstrate that the limitations of the IAC model in terms of generating new predictions in the area.

In conclusion, the data from the above experiments can be readily accommodated within an IAC style framework, but the limitation of specific models within this area has also been highlighted. As currently formulated the IAC style models which were tested above are clearly under-specified at the level of semantic representation, and fail to offer the possibility of new testable predictions regarding how personal information is structured. If these models are to be useful in promoting our understanding of how personal information is represented then they must be more rigorously specified in this important area.

## Future Research

Chapter 4 has shown us that when a semantic decision is made to a face at test, prior activation at the level of the PINs determines the level of priming found. Of course, there must be some mechanism that binds the process of identification and retrieval of a particular piece of semantic information. At present, it is unclear how such a mechanism might operate. However one way to circumvent the difficulty, which arises due to this activation at the PINs, is to use target stimuli that are not faces. Clearly, such stimuli would not produce direct activation at the level of the PINs. By using icons, similar to those used in Experiments 3.1 and 3.2, as target items (rather than as distractors) one might be able to observe patterns of interference at the level of the semantic system itself without the confounding influence of identity processing. Preliminary findings reported by Terry, Kay and Brennen (2001) suggest that such an approach may prove fruitful. In a series of six experiments, these authors demonstrate priming between faces and objects (and vice versa) for both familiarity and semantic decisions. In particular they show that the face of, say, David Seaman (presented for 250ms) facilitates a subsequent semantic decision relating to a pair of goalkeeping gloves (is this item associated with sport or not?). This result suggests that it may be possible to use items of this nature at test, to observe interference at the level of the semantic system. A line of enquiry following this methodology may allow us to begin to tease apart the effects that proved elusive in Chapters 2 and 3.

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# APPENDICES

## Appendix 1 (Relates to simulations 2.1, 2.2, 2.3)

The IAC simulations reported here were run using the Rochester Connectionist Simulator (Goodard, et al., 1989). The unit update function was the standard IAC update; see McClelland and Rumelhart (1988, p. 13) for equations.

The Hebb-like rule used for learning was taken from Burton (1994) and is as follows:

If $a_i a_j > 0$, $\Delta w_{ij} = \lambda a_i a_j (1 - w_{ij})$

Otherwise $\Delta w_{ij} = \lambda a_i a_j (1 + w_{ij})$

where $\lambda$ is a global learning rate parameter.

Global parameters were set as follows for all simulations.

Maximum unit activation = 1.0

Minimum unit activation = – .2

Rest = – .1

Decay rate = .1

External strength = .4

Alpha = .1

$\lambda$= .75

In each of the simulations all excitatory and inhibitory connections had strength .8 and – .8 respectively.

# APPENDIX 2
# Stimulus pairs used in Experiment 2.1

Set 1
Ronnie Barker/ Ronnie Corbett
Sarah Ferguson / Prince Andrew
Bob Geldof / Paula Yates
Sophie Rhys-Jones / Prince Edward
Jennifer Saunders / Dawn French
Hugh Laurie / Stephen Fry
Pamela Anderson / Tommy Lee
Doctor Spock / Captain Kirk
Nicole Kidman / Tom Cruise
Demi Moore / Bruce Willis
Jackie Onnasis / John F. Kennedy
Kurt Cobain / Courtney Love

Set 2
Prince Charles / Lady Diana
Liz Hurley / Hugh Grant
John Lennon / Paul McCartney
Nicholas Lyndhurst / David Jason
Richard Maddely / Judy Finnegan
Eric Morcombe / Ernie Wise
Paul Simon / Art Garfunkel
Carole Hathaway / Doug Ross
Bing Crosby / Bob Hope
Mia Farrow / Woody Allen
Andre Aggassi / Brooke Shields
Ginger Rogers / Fred Astaire

Set 3
Elaine C. Smith / Rab C. Nesbitt
Posh Spice / David Beckham
Prince Philip / The Queen
Bob Mortimer / Vic Reeves
Fred McCauley / Ali McCoist
Peter Cook / Dudley Moore
Kenny Rogers / Dolly Parton
Bobby Brown / Whitney Houston
Joe Dimaggio / Marilyn Monroe
Lois Lane / Clark Kent
Jerry Lewis / Dean Martin
Stan Laurel / Oliver Hardy

# APPENDIX 3
# Stimulus pairs used in Experiment 2.2

| List 1 | List 2 | List 3 | List 4 |
|---|---|---|---|
| *Prime* | *Prime* | *Prime* | *Prime* |
| Prince Edward | Hugh Grant | David Beckham | Tony Blair |
| Frank Butcher | Prince Charles | Prince Philip | Liam Gallagher |
| Tommy Lee | Kurt Cobain | Brad Pitt | Fox Mulder |
| Tom Cruise | Bruce Willis | John Goodman | Bill Clinton |
| Liz Hurley | Posh Spice | Cheri Blair | Sophie Rhys-Jones |
| Lady Diana | The Queen | Patsy Kensit | Peggy Butcher |
| Courtney Love | Jennifer Anniston | Dana Scully | Pamela Anderson |
| Demi Moore | Rosanne Barr | Hilary Clinton | Nicole Kidman |
| *Int Item* | *Int Item* | *Int Item* | *Int Item* |
| Rab C. Nesbit | Sean Connery | Sean Connery | Rab C. Nesbit |
| Frank Sinatra | Bob Dylan | Bob Dylan | Frank Sinatra |
| Clint Eastwood | Danny Devito | Danny Devito | Clint Eastwood |
| David Bowie | George Michael | George Michael | David Bowie |
| Bianca Butcher | Joanna Lumley | Joanna Lumley | Bianca Butcher |
| Madonn a | Tina Turner | Tina Turner | Madonn a |
| Julia Roberts | Brooke Shields | Brooke Shields | Julia Roberts |
| Annie Lennox | Geri Halliwell | Geri Halliwell | Annie Lennox |
| *Target* | *Target* | *Target* | *Target* |
| Sophie Rhys-Jones | Liz Hurley | Posh Spice | Cheri Blair |
| Peggy Butcher | Lady Diana | The Queen | Patsy Kensit |
| Pamela Anderson | Courtney Love | Jennifer Anniston | Dana Scully |
| Nicole Kidman | Demi Moore | Rosanne Barr | Hilary Clinton |
| Hugh Grant | David Beckham | Tony Blair | Prince Edward |
| Prince Charles | Prince Philip | Liam Gallagher | Frank Butcher |
| Kurt Cobain | Brad Pitt | Fox Mulder | Tommy Lee |
| Bruce Willis | John Goodman | Bill Clinton | Tom Cruise |
| | *Filler* | | *Filler* |
| | Rab C. Nesbit | | Sean Connery |
| | Frank Sinatra | | Bob Dylan |
| | Clint Eastwood | | Danny Devito |
| | David Bowie | | George Michael |
| | Bianca Butcher | | Joanna Lumley |
| | Madonn a | | Tina Turner |
| | Julia Roberts | | Brooke Shields |
| | Annie Lennox | | Geri Halliwell |

# APPENDIX 4
# Stimulus pairs used in Experiment 2.3

| Prime | IntItem | Target | Filler |
|---|---|---|---|
| Prince Edward | Rab C. Nesbit | Sophie Rhys-Jones | Madonna |
| Prince Philip | David Bowie | The Queen | Julia Roberts |
| David Beckham | Sean Connery | Posh Spice | Tina Turner |
| Frank Butcher | George Michael | Peggy Butcher | Brooke Shields |
| Tony Blair | Bianca Butcher | Cheri Blair | Clint Eastwood |
| Liam Gallagher | Annie Lennox | Patsy Kensit | Frank Sinatra |
| Prince Charles | Joanna Lumley | Lady Diana | Danny Devito |
| Hugh Grant | Geri Halliwell | Liz Hurley | Clint Eastwood |
| Dana Scully | Clint Eastwood | Fox Mulder | Bianca Butcher |
| Hilary Clinton | Frank Sinatra | Bill Clinton | Annie Lennox |
| Jennifer Anniston | Danny Devito | Brad Pitt | Joanna Lumley |
| Rosanne Barr | Clint Eastwood | John Goodman | Geri Halliwell |
| Pamela Anderson | Madonna | Tommy Lee | Rab C. Nesbit |
| Nicole Kidman | Julia Roberts | Tom Cruise | David Bowie |
| Courtney Love | Tina Turner | Kurt Cobain | Sean Connery |
| Demi Moore | Brooke Shields | Bruce Willis | George Michael |
| Fox Mulder | Rab C. Nesbit | Dana Scully | Madonna |
| Bill Clinton | David Bowie | Hilary Clinton | Julia Roberts |
| Brad Pitt | Sean Connery | Jennifer Anniston | Tina Turner |
| John Goodman | George Michael | Rosanne Barr | Brooke Shields |
| Tommy Lee | Bianca Butcher | Pamela Anderson | Clint Eastwood |
| Tom Cruise | Annie Lennox | Nicole Kidman | Frank Sinatra |
| Kurt Cobain | Joanna Lumley | Courtney Love | Danny Devito |
| Bruce Willis | Geri Halliwell | Demi Moore | Clint Eastwood |
| Sophie Rhys-Jones | Clint Eastwood | Prince Edward | Bianca Butcher |
| The Queen | Frank Sinatra | Prince Philip | Annie Lennox |
| Posh Spice | Danny Devito | David Beckham | Joanna Lumley |
| Peggy Butcher | Clint Eastwood | Frank Butcher | Geri Halliwell |
| Cheri Blair | Madonna | Tony Blair | Rab C. Nesbit |
| Patsy Kensit | Julia Roberts | Liam Gallagher | David Bowie |
| Lady Diana | Tina Turner | Prince Charles | Sean Connery |
| Liz Hurley | Brooke Shields | Hugh Grant | George Michael |
| Tony Blair | Bianca Butcher | Sophie Rhys-Jones | Clint Eastwood |
| Liam Gallagher | Annie Lennox | The Queen | Frank Sinatra |
| Prince Charles | Joanna Lumley | Posh Spice | Danny Devito |
| Hugh Grant | Geri Halliwell | Peggy Butcher | Clint Eastwood |
| Prince Edward | Rab C. Nesbit | Cheri Blair | Madonna |
| Prince Philip | David Bowie | Patsy Kensit | Julia Roberts |
| David Beckham | Sean Connery | Lady Diana | Tina Turner |
| Frank Butcher | George Michael | Liz Hurley | Brooke Shields |
| Pamela Anderson | Madonna | Fox Mulder | Rab C. Nesbit |
| Nicole Kidman | Julia Roberts | Bill Clinton | David Bowie |
| Courtney Love | Tina Turner | Brad Pitt | Sean Connery |
| Demi Moore | Brooke Shields | John Goodman | George Michael |
| Dana Scully | Clint Eastwood | Tommy Lee | Bianca Butcher |
| Hilary Clinton | Frank Sinatra | Tom Cruise | Annie Lennox |
| Jennifer Anniston | Danny Devito | Kurt Cobain | Joanna Lumley |
| Rosanne Barr | Clint Eastwood | Bruce Willis | Geri Halliwell |
| Tommy Lee | Bianca Butcher | Dana Scully | Clint Eastwood |
| Tom Cruise | Annie Lennox | Hilary Clinton | Frank Sinatra |
| Kurt Cobain | Joanna Lumley | Jennifer Anniston | Danny Devito |
| Bruce Willis | Geri Halliwell | Rosanne Barr | Clint Eastwood |
| Fox Mulder | Rab C. Nesbit | Pamela Anderson | Madonna |
| Bill Clinton | David Bowie | Nicole Kidman | Julia Roberts |
| Brad Pitt | Sean Connery | Courtney Love | Tina Turner |
| John Goodman | George Michael | Demi Moore | Brooke Shields |
| Cheri Blair | Madonna | Prince Edward | Rab C. Nesbit |
| Patsy Kensit | Julia Roberts | Prince Philip | David Bowie |
| Lady Diana | Tina Turner | David Beckham | Sean Connery |
| Liz Hurley | Brooke Shields | Frank Butcher | George Michael |
| Sophie Rhys-Jones | Clint Eastwood | Tony Blair | Bianca Butcher |
| The Queen | Frank Sinatra | Liam Gallagher | Annie Lennox |
| Posh Spice | Danny Devito | Prince Charles | Joanna Lumley |
| Peggy Butcher | Clint Eastwood | Hugh Grant | Geri Halliwell |

# APPENDIX 5
## Stimulus pairs used in Experiment 4.1

Set 1
Ronnie Barker/ Ronnie Corbett
Sarah Ferguson / Prince Andrew
Bob Geldof / Paula Yates
Sophie Rhys-Jones / Prince Edward
Jennifer Saunders / Dawn French
Hugh Laurie / Stephen Fry
Pamela Anderson / Tommy Lee
Doctor Spock / Captain Kirk
Nicole Kidman / Tom Cruise
Demi Moore / Bruce Willis
Jackie Onnasis / John F. Kennedy
Kurt Cobain / Courtney Love

Set 2
Prince Charles / Lady Diana
Liz Hurley / Hugh Grant
John Lennon / Paul McCartney
Nicholas Lyndhurst / David Jason
Richard Maddely / Judy Finnegan
Eric Morcombe / Ernie Wise
Paul Simon / Art Garfunkel
Carole Hathaway / Doug Ross
Bing Crosby / Bob Hope
Mia Farrow / Woody Allen
Andre Aggassi / Brooke Shields
Ginger Rogers / Fred Astaire

Set 3
Elaine C. Smith / Rab C. Nesbitt
Posh Spice / David Beckham
Prince Philip / The Queen
Bob Mortimer / Vic Reeves
Fred McCauley / Ali McCoist
Peter Cook / Dudley Moore
Kenny Rogers / Dolly Parton
Bobby Brown / Whitney Houston
Joe Dimaggio / Marilyn Monroe
Lois Lane / Clark Kent
Jerry Lewis / Dean Martin
Stan Laurel / Oliver Hardy

# APPENDIX 6
## Stimulus pairs used in Experiment 4.2

Set 1
Lady Diana / Prince Charles
Bob Geldof / Paula Yates
Bob Mortimer / Vic Reeves
Cheri Blair / Tony Blair
Hilary Clinton / Bill Clinton
Dana Scully / Fox Mulder
Bob Hope / Bing Crosby
John Goodman / Rosanne Barr

Set 2
Ernie Wise / Eric Morcombe
Sarah Ferguson / Prince Andrew
Paul McCartney / John Lennon
Liam Gallagher / Noel Gallagher
Demi Moore / Bruce Willis
Mathew Perry / Courtney Cox
Niles Crane / Fraser Crane
Courtney Love / Kurt Cobain

Set 3
David Beckham / Posh Spice
Liz Hurley / Hugh Grant
Prince Philip / The Queen
Nicholas Lindhurst / David Jason
Tommy Lee / Pamela Anderson
JF Kennedy / Marilyn Monroe
Nicole Kidman / Tom Cruise
Michael Glassier / David Soul

# APPENDIX 7
## Stimulus pairs used in Experiment 4.3

List 1
Prince Edward / Sophie Rhys-Jones
Bob Geldof / Paula Yates
Tommy Lee / Pamela Anderson
Tom Cruise /Nicole Kidman
Liz Hurley / Hugh Grant
Lady Diana / Prince Charles
Courtney Love / Kurt Cobain
Demi Moore / Bruce Willis

List 2
Hugh Grant / Liz Hurley
Prince Charles / Lady Diana
Kurt Cobain / Courtney Love
Bruce Willis / Demi Moore
Posh Spice / David Beckham
The Queen / Prince Philip
Jennifer Anniston / Brad Pitt
Roseanne Barr / John Goodman

List 3
David Beckham / Posh Spice
Prince Philip / The Queen
Brad Pitt / Jennifer Anniston
John Goodman / Roseanne Barr
Anthea Turner / Grant Bovey
Patsy Kensit / Liam Gallagher
Jackie Onassis / John F. Kennedy
Ginger Rogers / Fred Astaire

List 4
Grant Bovey / Anthea Turner
Liam Gallagher / Patsy Kensit
John F. Kennedy / Jackie Onassis
Fred Astaire / Ginger Rogers
Sophie Rhys-Jones / Prince Edward
Paula Yates / Bob Geldof
Nicole Kidman / Tom Cruise
Pamela Anderson / Tommy Lee

# APPENDIX 8
## Stimulus pairs used in Experiment 4.4

List 1
Prince Edward / Sophie Rhys-Jones
Frank Butcher / Peggy Butcher
TommyLee / Pamela Anderson
Tom Cruise / Nicole Kidman
Liz Hurley / Hugh Grant
Lady Diana / Prince Charles
Courtney Love / Kurt Cobain
Demi Moore / Bruce Willis

List 2
Hugh Grant / Liz Hurley
Prince Charles / Lady Diana
Kurt Cobain / Courtney Love
Bruce Willis / Demi Moore
Posh Spice / David Beckham
The Queen / Prince Philip
Jennifer Anniston / Brad Pitt
Roseanne Barr / John Goodman

List 3
David Beckham / Posh Spice
Prince Philip / The Queen
Brad Pitt / Jennifer Anniston
John Goodman / Roseanne Barr
Cherie Blair / Tony Blair
Patsy Kensit / Liam Gallagher
Dana Scully / Fox Mulder
Hillary Clinton / Bill Clinton

List 4
Tony Blair / Cherie Blair
Liam Gallagher / Patsy Kensit
Fox Mulder / Dana Scully
Bill Clinton / Hillary Clinton
Sophie Rhys-Jones / Prince Edward
Peggy Butcher / Frank Butcher
Nicole Kidman / Tom Cruise
Pamela Anderson / Tommy Lee

# APPENDIX 9
# Stimulus pairs used in Experiment 4.5

List 1
Prince Edward / SophieRhys-Jones
Frank Butcher / Peggy Butcher
Tony Blair / Cherie Blair
TommyLee / Pamela Anderson
Tom Cruise / Nicole Kidman
Fox Mulder / Dana Scully
Liz Hurley / Hugh Grant
Lady Diana / Prince Charles
Patsy Kensit / Liam Gallagher
Courtney Love / Kurt Cobain
Demi Moore / Bruce Willis
Bill Clinton / Hillary Clinton

List 2
Hugh Grant / Liz Hurley
Prince Charles / Lady Diana
Liam Gallagher / Patsy Kensit
Kurt Cobain / Courtney Love
Bruce Willis / Demi Moore
Bill Clinton / Hillary Clinton
Posh Spice / David Beckham
Zoe Ball / Norman Cook
The Queen / Prince Philip
Jennifer Anniston / Brad Pitt
Roseanne Barr / John Goodman
Catherine Zeta-Jones/Michael Douglas

List 3
David Beckham / Posh Spice
Norman Cook / Zoe Ball
Prince Philip / The Queen
Brad Pitt / Jennifer Anniston
John Goodman / Roseanne Barr
Michael Douglas/Catherine Zeta-Jones
SophieRhys-Jones / Prince Edward
Peggy Butcher / Frank Butcher
Cherie Blair / Tony Blair
Pamela Anderson / Tommy Lee
Nicole Kidman / Tom Cruise
Dana Scully / Fox Mulder

Note: Appendices 4.1 to 4.5 include only the critical stimulus pairs used. The method sections describe how these stimuli are manipulated (and combined with non-critical stimuli) to produce stimulus pairs for the different conditions in each experiment.