Thesis 4417

Learning Person-Specific Knowledge about New People

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To my grandparents: Tom and Margaret Wilson, and George and Nan Smith

For my grandparents: Tom and Margaret Wilson, and George and Nan Smith.

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Declaration

I declare that this thesis is my own work unless indicated otherwise in the text, carried out under the normal terms of supervision.

Abstract

Much progress has been made in the last twenty years or so on understanding the cognitive processes involved in familiar person recognition (see, for instance, Burton, Bruce, and Hancock, 1999). Indeed both Burton and colleagues (Burton et al., 1999) and Bredart and colleagues (Bredart, Valentine, Calder, Gassi, 1995) have proposed implemented models of several aspects of familiar person recognition. Yet models such as these presuppose the prior process of person familiarisation. A satisfactory theory of person processing needs to address not only familiar person processing but also unfamiliar person processing, and most critically, the familiarisation process which bridges the gap between these two categories.

There is much evidence to suggest, moreover, that familiar and unfamiliar people are processed by the cognitive system in different ways. Yet studies investigating the gradual transition phase by which a person changes from being unfamiliar to being highly familiar are relatively rare. Some research has been carried out on the perceptual changes which accompany familiarisation (e.g. O'Donnell & Bruce, 2001). Perceptual change, however, is only one component of familiarisation. The other critical component is forming knowledge about the individual (i.e. semantic knowledge). There has hardly been any research on semantic familiarisation to date. The aim of this thesis is to obtain evidence pertaining to the issue of semantic familiarisation which should constrain future models of person processing.

I review models of familiar person recognition in chapter one of the present thesis and further identify the gap existing in the literature with respect to semantic aspects of familiarisation. I also offer arguments as to the intrinsic importance of including familiarisation in any theory of person processing. The first experimental chapter investigates, by means of both verification and cued-recall tasks, whether a script-like representation of person-specific knowledge may prove more fruitful than current mechanisms of representing such knowledge in the course of learning about new people. I conclude that an explanation in terms of general memory theory best fits the results obtained in this chapter.

The second experimental chapter moves away from the learning methodology used in first chapter to employ a much more ecologically valid learning paradigm. That

is, as opposed to using one simple face image and a set of semantic properties I use an initially unfamiliar soap opera with which participants gradually become familiarised. I consider the structure of person-specific knowledge for both a set of famous people and further a set of characters from the soap opera. Results here suggest that occupations are the important category for famous persons but that, for a newly learned set of individuals, relational information is more important. I again examine these questions using both recall and verification tasks in this chapter. I argue that one critical factor in determining preferential representation of a given type of information in the representation of person-specific knowledge for some person is the co-occurrence frequency of encountering that person with that class of information.

The final experimental chapter (Chapter 4) attempts to investigate the processes of semantic familiarisation in an on-line manner. I use a self-priming paradigm (see Calder & Young, 1996) to probe the development of participants' semantic representations at regular intervals across a learning period. I report both within-domain and cross-domain experiments addressing this issue. Results indicate that after a relatively short interval newly learned persons behave comparably to famous persons in several important respects. Existing theories of general memory (e.g. Logan, 1988; McClelland & Chappell, 1998) account well for the perceptual familiarisation which occurs in the reported experiments. Further development is required, however, to account for the results on semantic familiarisation.

I summarise and evaluate the experiments reported in the present thesis in the final chapter and also attempt some theoretical development which should provide useful for the creation of a unified theory of person processing.

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Chapter 1

Person Recognition and the Importance of Familiarisation

1.1 General Introduction

This thesis begins from the consideration that current models of familiar person recognition do not explain the processes of familiarisation. Yet any model of familiar person recognition must presuppose the prior processes of familiarisation. Thus any satisfactory theory of person recognition has to not only account for a "snapshot" of the adult person recognition system but, in addition, must account for the learning of new people by the system. To date models of person recognition have almost exclusively focused on the "snapshot" view, to the exclusion of new learning from the system (see Burton, 1994, for a rare exception which addresses the learning of new faces). The aim of this thesis is, primarily, to examine the processes of semantic familiarisation, which is an area that has not seen much research to date. The experiments reported should constrain future models of familiarisation. I also attempt some theoretical development that should prove useful for future delineation of a full-spectrum[2] model of person recognition.

1.1.1 Outline

In the present introductory chapter, after introducing the task of person recognition and situating it within general object recognition, I review current theories of person recognition to highlight what they can currently explain. I then consider evidence pertinent to the problem of semantic knowledge representation and processing since the focus of this thesis is on semantic familiarisation. The next section explores the phenomena of familiarisation and some attempts to explain aspects of the process. In the penultimate section I offer arguments as to why a satisfactory theory of person

[2] I use the term 'full-spectrum model' to refer to any model which is inclusive of the processes of familiarisation.

recognition must include familiarisation before criticising current theories of person recognition with respect both to internal problems in those theories and to problems of scope. Finally I provide an outline of the remaining chapters of this thesis.

1.2 Person Recognition

Bruce, Burton and Craw (1992) take the task of face recognition, which is one domain of person recognition, to be "the retrieval of identity-specific semantic codes from faces that vary from minute to minute". Sergent and Signoret (1992), moreover, take the task of face recognition to be the guidance of social interaction. There is no disagreement between these two views since for face recognition to be able to guide social interaction successfully one must have access to relevant person-specific knowledge. Generally, given the above, the task of person recognition could be formulated as the classification of a person-specific stimulus (such as a face, name or voice) into either the known or unknown categories, and retrieval of appropriate knowledge in each case, which then guides social interaction.

Early work in familiar person recognition suggested that the process could be broken down into several stages (e.g. Young, Hay & Ellis, 1985). The evidence from Young et al.'s (1985) study was in the form of errors participants made in keeping diaries of problems encountered in person recognition. Common errors were encountering a familiar person but not recognising them, recognising an individual as familiar but not being able to retrieve any semantic knowledge about the person, and recognising an individual as familiar and being able to access semantic knowledge about them but not some specific knowledge (such as their name). These different types of error provide a window into the functioning of the person recognition system. They also suggest the lower level functions of the person recognition system, such as determining the familiarity of a person, retrieving semantic knowledge about a familiar person, and retrieving knowledge of a familiar person's name. To perform these functions the system must access memories of familiar individuals. It is with the formation and development of such memories that the present thesis is concerned.

1.2.1 Recognition

Stepping back to a level of greater generality, from person recognition to just recognition, gives a clearer view of what recognition is for and further allows person recognition to be situated within generic object recognition.

1.2.1.1 Object Recognition

Recognition, most fundamentally, allows differentiation of objects in the environment. The evolutionary importance of being able to successfully discriminate objects in the environment is clearly paramount. Quite simply an organism can suffer premature mortality or avoidable morbidity by faulty recognition (cp. Pearce, 1998).

Recognition, moreover, can be performed at multiple levels of specificity (Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976; [cited in Tanaka and Taylor, 1991]): the basic, superordinate and subordinate levels of categorisation (e.g. one can recognise a human as an animal (superordinate) or as a person (basic) or as a specific person (subordinate)). The basic level, furthermore, has a special status in generic object recognition due to participants: A) being more likely to spontaneously name an object at that level, B) being faster to perform categorization tasks at that level, C) and, critically, producing more *new* features at that level in a feature listing task, as opposed to the other two levels (Rosch et al., 1976; [cited in Tanaka and Taylor, 1991]). The level of categorisation at which these three criteria are manifested is commonly the basic level for objects; however, for object classes with which one has sufficient experience, processing at a subordinate level can result in equivalent performance with the basic level, or even result in improved performance relative to the basic level on some measures.

Thus bird experts, for instance, produce the same amount of new features at the subordinate level as at the basic level, perform as fast at the subordinate level as the basic level in verification tasks, and name birds much more frequently at the subordinate level (Tanaka & Taylor, 1991). Tanaka (2001), moreover, has shown that human face categorisation (and I presume by extension, person recognition) at the unique identity level (e.g. recognising a face as "Tony Blair") is more likely than at the basic level (e.g. as a person) and further that categorisation speed is equivalent across the unique identity and basic levels.[3] Thus humans are often claimed to be face recognition experts on the above basis, since categorisation is as fast and more likely at the unique identity level than the basic level. Humans may be *familiar* face recognition experts but are certainly not *unfamiliar* face recognition experts (see Burton, Wilson, Cowan & Bruce, 1999, for some work highlighting familiar / unfamiliar processing differences for faces). Indeed Tanaka's work only demonstrates that humans are face experts with *familiar* faces. This distinction is important. It indicates that one has to learn to be an expert with any given face. An additional, general, point to take from the above discussion is that the structure of one's categorical representation for a given class of objects can change with sufficient perceptual experience of that class of objects.

1.2.1.2 Person Recognition as Unique Identity Object Recognition

In terms of evolution, as, for instance, Sergent and Signoret (1992) have commented: "Any social animal must possess the capacity to differentiate [...] members of its own group" into salient categories such as potential mate or threat to one's position. This clearly requires that humans be able to recognise other humans at a sub-subordinate level, that is, at a unique identity level (see Tanaka, 2001).

Thus the task of person recognition is then to differentiate each encountered person into either the known or the unknown type, and further if known to retrieve semantic knowledge about the individual to allow unique identification, and by means of these two actions to thus guide social interaction. The goal is of course to aid towards successful social interaction, with successful being defined in an evolutionary manner. Thus person recognition is not an end in itself but a means to successful social interaction. The importance of person recognition in this task is not slight.

Now that I have articulated the primary task of person recognition it is simpler to specify what a theory of person recognition must be able to account for. A satisfactory theory of person recognition must account, minimally, for the classification

[3] How the finding that occupations are verified faster than names for familiar faces (e.g. Young, Ellis & Flude, 1988) fits into this view is not clear. Occupations are clearly more super-ordinate than names yet are processed faster than names and, by implication, than basic level terms. This, however, is only one of the measures used to define the basic level.

of individuals according to their identity (into the known familiar, known with unique identity or unknown categories).

One vital addition, however, to this basic condition, is that such a theory should be able to account for the transition of a given individual from being unfamiliar to being familiar. It should be able to account for the changes occurring in the person recognition system in tandem with the subjective transformation of familiarity for a perceiver. The person recognition system does not consist of a fixed number of individuals for the lifetime of a given human; rather the individuals present in a given human's person recognition system change with time. A satisfactory theory of person recognition must be able to account for this feature. Requiring that a theory be able to account for this *familiarisation* process means that one must consider learning. Learning of new people is, I will argue, a fundamental property of the person recognition system and further is the focus of the present work.[4]

1.2.1.3 Knowledge and Different Levels of Recognition

To determine the familiarity of some person reference need only be made to perceptual components of memory. To determine unique identity, however, requires access to semantic knowledge about the given individual. Indeed the "feeling of knowing" phenomenon occurs when the perceiver knows that the person they are trying to identify is familiar yet cannot place them (see Young, Hay & Ellis, 1985).[5] Semantic knowledge of the target person is required to resolve this problem (Bruce & Young, 1986). Thus different types of knowledge are required for recognition at different levels of specificity and more importantly, semantic knowledge is critical for unique identity level recognition.

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[4] It is interesting to note that not all types of recognition would have to operate in this manner – that is, with constant addition of new members to the system. Consider the recognition of edible food types. This may remain constant for a given individual over their lifetime. Yet one would expect the facility to be able to add new members to be a property of the recognition system in general and whether it is used in any one case of recognition to depend on environmental constraints.

[5] Interestingly Hanley, Smith and Hadfield (1998) have shown that there are many more occurrences of this type with voices as opposed to faces, and they also ruled out a simple explanation in terms of participants simply using different criteria for faces and voices.

1.2.2 Theories of Familiar Person Recognition

I now move to consider theories of person recognition which have a bearing on the work reported in the later chapters of this thesis. In this section I consider only those aspects of the theories which concern familiar person or face recognition. The latter two models reviewed are solely models of familiar person recognition but the first theory also contains some explanation of familiar / unfamiliar processing differences upon which I will comment in a later section (1.2.4).

1.2.2.1 The Bruce & Young Model of Face Recognition

Bruce and Young's (1986) broad theoretical outline of face recognition has provided the impetus for much work which has followed in person recognition. Their paper immediately reminds one that the human face is useful for many distinct purposes such as identification, inferring the expression of the bearer (and thus mood) and in speech recognition (see also Bruce, 1990). The goal one day, of course, is to have a theory with enough explanatory content to address these different aspects of using the face (and indeed the voice as well). For the present, however, it is the familiar face recognition route of this model that is the current interest.

In short, view-centred and expression-independent descriptions are derived from the face input (see Figure 1, next page). These descriptions then activate Face Recognition Units (FRUs), of which there is one for each face known. These units respond to any 'recognisable' view of the known face (they are thought to signal a 'resemblance' value). The FRU will then activate (or retrieve) semantic knowledge, located in the Person Identity Nodes (PINs), which the authors take to be an area of associative memory. Subsequent to the PINs there is a box for name generation which can only be accessed after accessing the PINs. According to this model, person recognition occurs at the level of the PINs, as these are multi modal convergence sites (for voice, face, semantic, and other types of information that aids person recognition).

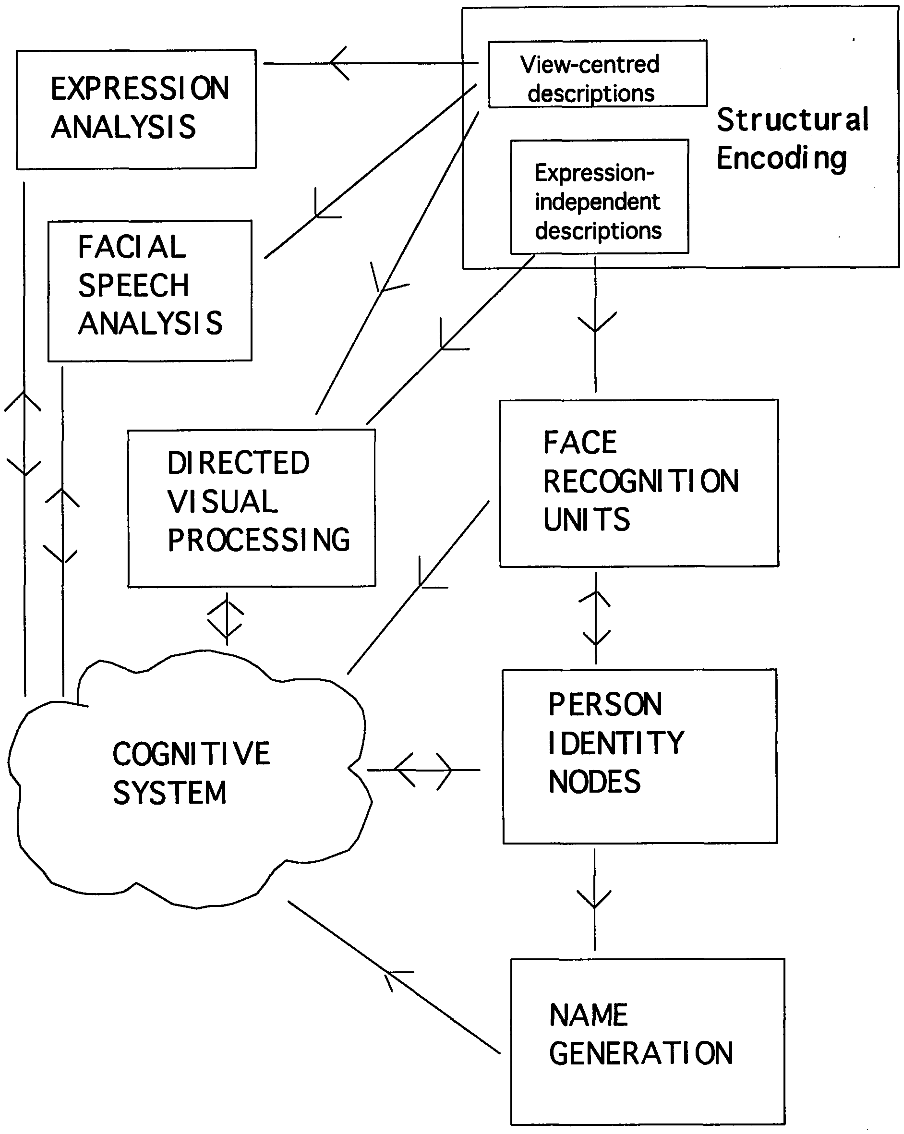

Figure 1: Bruce & Young's (1986) functional model of face recognition[6]

This model posits the tripartite division of familiar person recognition into a perceptual stage (here FRUs), followed by a semantic stage (here PINs), followed finally by a name generation stage. Evidence supporting this broad functional outline has come from multiple sources such as diary studies (Young, Hay & Ellis, 1985), laboratory studies (Young, McWeeny, Hay & Ellis, 1986a; Young, McWeeny, Ellis & Hay 1986b) and neuropsychological studies (Flude, Ellis & Kay, 1989). Furthermore

[6] Thanks to Derek Carson for providing images of the three models considered in this section.

the evidence suggests that access to a name just cannot occur without first accessing semantics (but see Brennen, 1996, for a contrasting neuropsychological case study).

This model of Bruce and Young was an important development in the progress of models of person recognition though it has now been superseded, in terms of the familiar person recognition component, by the IAC model of Burton, Bruce and Johnson (1990). The IAC model has a much greater explanatory content in the domain of person recognition. The IAC model of Burton et al. (1990) was conceived as an implementation of the broad functional framework outlined by Bruce and Young with the stated aim being to make that functional outline *explicit*. Before describing the original IAC model and a revised version the IAC model (Bredart et al., 1995) I will first describe the key data that the IAC model was initially created to account for.

1.2.2.2 Some Simple Phenomena of Familiar Person Recognition[7]

Repetition priming and associative (often called semantic) priming are two of the main phenomena of person recognition. Repetition priming refers to the benefit in response latency when responding to some item for the second time relative to the first time response for some other item. Thus making a familiarity decision to David Beckham's face is speeded if one has recently come across his face in some other task (see Bruce & Valentine, 1985). Repetition priming occurs with faces, names and voices and does not cross stimulus domains unless the tasks used are semantic in nature (see Bruce & Valentine, 1985; Ellis, Jones & Mondell, 1997 and Burton, Bruce & Kelly, 1998, respectively). It is long lasting, occurring over intervening items and over temporal intervals of several minutes. Associative priming, on the other hand, refers to the general speeding of response to a target stimulus when it is preceded by a related as opposed to an unrelated prime stimulus. Thus response latency is faster to make a familiarity decision to David Beckham's face after processing Victoria Beckham's face, relative to after processing Bruce Willis' face (see Bruce & Valentine, 1986). Associative priming occurs with any combination of faces and names as primes and targets and is hence cross-domain in nature (see Ellis et al., 1997, for a demonstration

[7] Note these phenomena are all phenomena of *familiar* person recognition; for a selective review of familiar compared with unfamiliar person processing see section 1.2.4.

of a type of associative priming between faces and voices in each direction). It also occurs using either a familiarity decision or a semantic decision task (McNeill & Burton, 2002). Associative priming is short-lived (on the order of seconds) and does not survive an intervening item (Bruce, 1986).

These two effects are some of those that the Interactive Activation and Competition (IAC) model of Burton et al. (1990) was developed to account for. In the intervening years, however, much research has added to these initial effects described above and this research will be commented on in a later section.

1.2.2.3 The IAC Model

The IAC model of Burton et al. (1990) consists, essentially, of four pools of interacting units (see Figure 2, next page). The Face Recognition Units (FRUs) code familiar faces; there is a different unit for each familiar face and further each unit responds to all "recognisable" views of the given familiar face. Upon perceiving a familiar face then the FRU for that face would gain in activation. This activation would be passed on to the Person Identity Node (PIN) for that same person. (Name Recognition Units [NRUs] work in a similar manner to the FRUs; these are the second pool of units) The PINs, the third pool of units, are a site of multimodal convergence (from faces, names and voices) and are where familiarity decisions are signalled when one unit passes some arbitrarily set threshold (constant for all PINs). Once the PIN has been activated it then passes the activation on to the Semantic Information Units (SIUs) to which the given person is linked. (Note this is different from the original Bruce and Young (1986) model where semantic knowledge was part of the PINs.) SIUs code semantic information such as "politician", "Prime Minister" and so on. Importantly SIUs are *shared* across individuals whereas there is a unique FRU, NRU and PIN for each known person. Thus two people who are both "British" would have this represented in the model by each of their respective PINs both being linked to the single "British" SIU. All units within a given pool are linked with inhibitory connections and further units representing the same individual are linked between pools with excitatory links. All links are bidirectional. Furthermore, when any Recognition

Unit and PIN of the same person are active at the same time the link between them is strengthened. (In latter versions this link strengthening applies to *any* two units of the same individual. This difference is important for the model to be able to explain cross-domain repetition priming on semantic decisions. This is where a participant makes a semantic decision at prime to say a target's face and then after the standard interval (on the order of minutes) makes a semantic decision to the same target's name. Facilitation is observed for semantic decisions at prime and test but not for familiarity decisions at prime and test. See Burton et al., 1998).

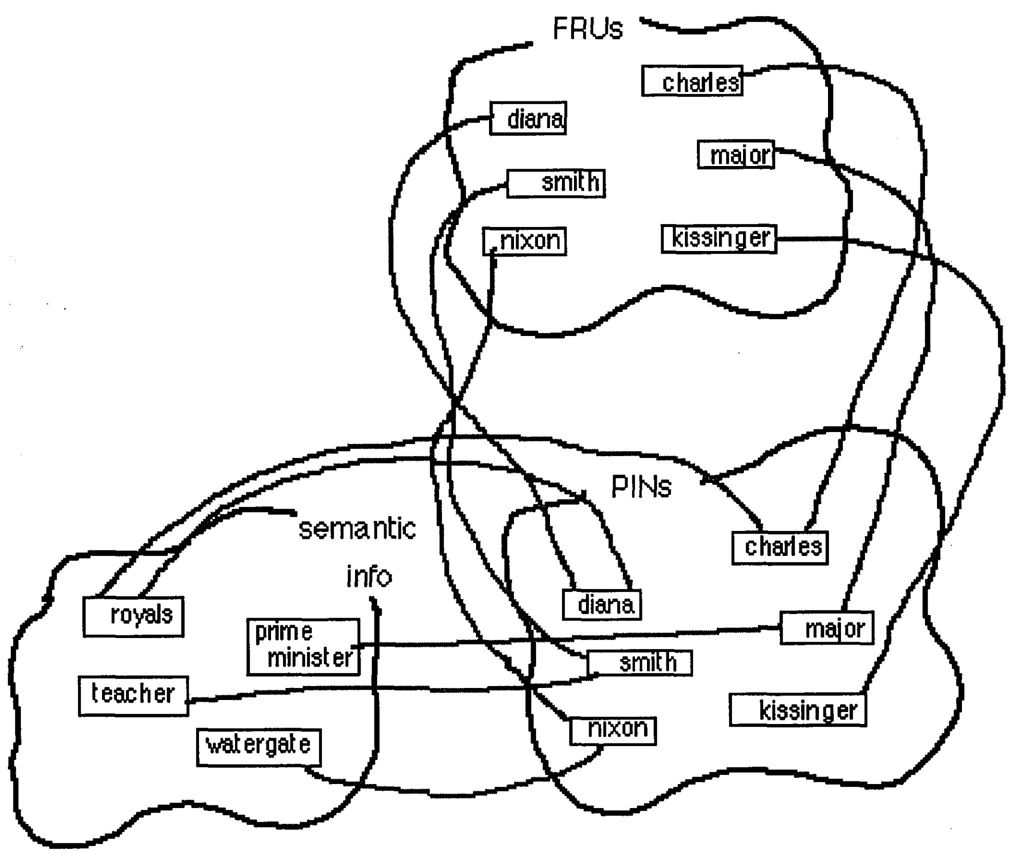

Figure 2: Central architecture of Burton et al.'s (1990) model of face recognition[8]

[8] This diagram does not show the additional input unit pool (i.e. the NRUs). These units are simply connected to the PINs in an analogous manner to the FRUs.

From the outline above it is now possible to derive explanations of both repetition and associative priming from the IAC model. The fact that one is faster to respond to a face (or name or voice) the second time one has experienced it can be explained as being due to the link strengthening which occurs between the FRU and PIN each time a given person is processed by the system. If you have viewed one face n more times than some other face then you will be quicker to respond to the face you have seen more often since the link between the FRU and PIN for that face will be much more developed (and hence stronger) and thus the link will be traversed more speedily than the FRU-PIN link for the face you have seen n less times.

The explanation of associative priming, on the other hand, rests on the interaction between the PINs and the SIUs at the other end of the model. On perceiving David Beckham's face, for instance, his FRU will fire, followed by his PIN. This in turn will activate the SIUs to which he is related (e.g. "British", "footballer" etc). Due to the bidirectional nature of the links between the SIUs and the PINs, some of the SIU activation flows back to the PINs of people connected to that information. Thus activation would flow back to David Beckham's PIN (maximally) but also to the PINs of other individuals who share some semantic information with him. Thus Victoria Beckham's PIN would be at an above resting level of activation, due to this SIU feedback, allowing a familiarity decision to subsequently be made faster to her than if there were much less feedback from the SIUs to her PIN (which would be the case if she was preceded by, say, Bruce Willis). Thus the IAC model explains the basic effect of associative priming.

It can also explain, in a simple manner, why associative priming is cross-domain in nature whereas repetition priming is within-domain unless a semantic task is used. Simply put the reason associative priming crosses stimulus domains (i.e. a face primes a face to the same extent as a face a name etc) is that the effect is due to PIN-SIU interaction, which is well downstream of any perceptual input. This is not the case for repetition priming, unless a semantic decision is used. I also note that there are two main theoretical mechanisms in the IAC model: the first is link strengthening between any two simultaneously active units of the same individual which captures repetition effects and the second is the degree of semantic sharing between two individuals. The latter capturing associative priming effects. The model also accounts for the different time course of associative and repetition priming effects. Briefly, link strengthening, responsible for repetition priming, is a long-term change which thus affects subsequent recognition of some individual. Thus repetition priming is long lasting. In associative priming, on the other hand, any advantage for a related individual (by transient increase in activation level of their PIN) is wiped out by the activation of another, unrelated, PIN due to within pool competition. Associative priming, then, is wiped out by an intervening item. Thus the IAC model accounts very successfully for the pattern of associative and repetition priming effects found in person recognition.

Many additional findings have either been accommodated within the original IAC model or have stimulated its development. Carson and Burton (2001) for instance, have demonstrated *true*[9] semantic priming (or categorical priming) by using a multiple prime procedure. The IAC model also captures the effect of distinctiveness with some simple extensions prior to the FRU pool of units (see Burton et al., 1990). Burton, Bruce & Hancock (1999), moreover, added a perceptual front-end to the original IAC model, utilising Principal Components Analysis of facial images.

Calder & Young (1996), in addition, derived a series of predictions from the original IAC model regarding self-priming and all were successfully corroborated in a set of experiments. Self-priming is a type of associative priming where the prime and target are both referents of the same individual. (I will discuss self-priming at length in chapter four of this thesis where I use it to tap the processes of perceptual and semantic familiarisation.) An explanation of covert face recognition seen in some prosopagnosic patients has also been offered (Burton, Young, Bruce, Johnson & Ellis, 1991 [cited in Burton et al., 1999]). Burton and Bruce (1992; 1993) have also attempted to account for name generation and name recognition. Their novel approach to name processing takes names to be a standard SIU located in the SIU pool alongside other semantics. The reason offered for the difference in processing of names compared to other semantics is the pattern of connectivity for names compared to the other semantics. Names are, generally speaking, unique, whereas other semantic information in the IAC model is

[9] True in the sense of there being no overt association between the related items and the target.

shared. Debate still ensues, however, concerning how best to account for the name problem (see Carson et al., 2000).

Finally, Burton (1994) extended the original IAC model to account for the learning of new faces. Thus the model has clearly been applied across a wide range of phenomena in familiar person recognition with much success. This offering is only a selection (see Burton et al., 1999, for other explainable effects). There are, however, a number of problems with the IAC model as a model of person recognition and I will expound these in a latter section (section 1.4).

1.2.2.4 The IAC Model of Bredart et al. (1995)

Bredart, Valentine, Calder & Gassi (1995) offered a different version of the original IAC model, with two major changes. The reason offered for the first change was that the IAC model as it stood predicted that the more pieces of semantic information that someone knows for any given person the slower one should be to retrieve any one of those semantic facts. The prediction depends on assuming that semantic decisions are taken when the relevant SIU passes some set threshold.[10] The predicted effect is due to the inhibitory action on each SIU caused by the activation of the n other SIUs connected to the same

[10] See also section 1.4.1.1.

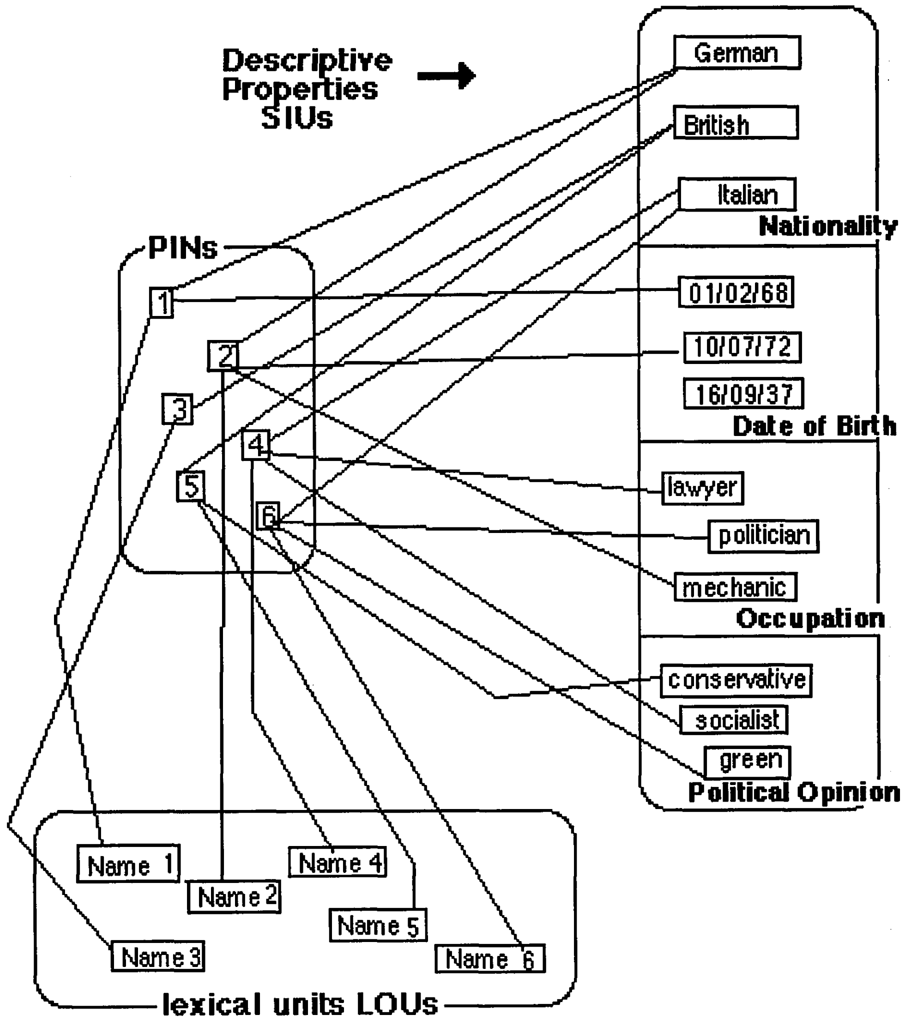

Figure 3: Post input architecture of Bredart et al.'s (1995) model of face naming

person. Bredart et al. test this prediction empirically and refute it by showing that those famous persons for whom more semantic knowledge is known are named *faster* than those for which less semantic knowledge is known (names, in the IAC model, are just another standard SIU). Bredart et al. propose two changes to the original IAC model. In the original IAC model all semantic information is represented together in one pool (the SIU pool), whereas in Bredart et al.'s revised model, semantic information is differentiated into several separate pools (see Figure , above). This is the first change and allows the authors to account for the experiment described above. Thus in their model there are separate pools of semantic information for different categories of such information, such as nationality, occupation etc and activation of a unit in one of these semantic pools does not inhibit activation of semantic units in other semantic pools. Thus these authors report that, in their model, the more semantic information that is known about a given individual the faster a decision about any semantic fact can be made. The second change, furthermore, is that in Bredart et al.'s model there is a separate pool of units for name output whereas in the original IAC model names were taken as just another type of SIU (see below).

Using this architecture also allows the authors to account for the reports of preserved access to unique person-specific knowledge with poor access to names (see Bredart et al., 1995), a finding which the original IAC model cannot account for. Thus this model does have some advantages over the original IAC model. Indeed it is fair to say that at present, due to the similar structure of the two models, that the revised IAC model, if successful, would have a greater explanatory content than the original IAC model (since it can account, in principle, for all the effects that the original model can plus some other effects). In the domain, however, in which the revised IAC model extends the original model there are some problematical issues (see McNeill, 2002, for attempts to distinguish between the two models with regard to semantics).

Bredart et al., for example, argue for the location of names in a separate output lexicon pool due to considering face naming from an alternative perspective, that of speech production. Face naming, it is clear, is an act of speech production. Naming a semantic detail about a person, say occupation, nevertheless, is surely also an act of speech production though there is no proposal for a separate pool of output units for each type of semantic detail (see also McNeill, 2002). How does one produce the semantic category to which a face belongs, in this model?

Valentine, Brennen and Bredart (1996) offer a framework for face and name processing which includes some developments from the model of Bredart et al. With respect to the main issue, that of producing person-specific knowledge about a person, this model seems to suggest that to produce information of this sort one has to proceed through a pool of general semantics. Is there any need, however, to have access to general semantics to be able to produce person-specific semantics? This issue is left unresolved. This seems to be another stage than is required in the original IAC model. Perhaps this difference can be recruited to test between the two models.

Thus while the revised model of Valentine et al. has some advantages over that of Burton and colleagues in the domain of naming a face or a name, there are some serious problems with this model as well (see also section 1.2.4). Thus models of familiar person recognition can explain much data in the field and serve as a benchmark for any new theory of person recognition. The models, however, are subject to several problems which I detail in a later section (1.2.4). I now move to consider some neuropsychological evidence relevant to the semantic processing of people before considering different possible forms of semantic representation – that is instance-based representation or a prototype representation of semantic knowledge.

1.3 Semantic Knowledge: Representation & Processing

Semantic knowledge is critical for successful familiar person recognition. For successful social interaction, one does not simply need to know that a given person is familiar, rather one needs to know why – that is, one needs to access knowledge about the individual. How is such information represented in long-term memory? Semantic knowledge acquisition, furthermore, is critical to the familiarisation process. I initially review some evidence from neuropsychology which suggests some broad constraints on such representations. I then consider some models of semantic representation with an eye to the process of semantic knowledge acquisition.

1.3.1 Broad Constraints from Neuropsychology

The central problem of person recognition, to reiterate, is to differentiate each encountered person into either the known or the unknown categories, and further if known to retrieve semantic knowledge about the individual to allow unique identification, and by means of these two actions to thus guide social interaction. It is the goal, of course, to have a theory of person recognition which successfully accounts for the performance of both normal participants and those with various types of brain disorder. A theory which can do both will have a higher explanatory content than one which can only explain either normal performance or impaired performance. The emphasis in this section is on the constraints which can be obtained from studying neuropsychological patients in order to further delineate models of person recognition, with especial respect to the appropriate mode of semantic representation.

Ellis, Young, and Critchley (1989) reported a patient who suffered from epilepsy and had had a right temporal lobectomy performed (inclusive of the hippocampus and amygdala). This patient displayed grossly impaired levels of processing on tasks requiring explicit famous person knowledge (accessing from faces, names and voices; performance for low familiarity faces on familiarity rating and occupation generation was within two standard deviations of control participants though naming was much lower). Yet general semantic processing of objects (both living and non-living) was preserved in naming and category membership tasks. When processing of famous buildings and famous animals was investigated, however, the patient also showed significant impairment. Thus the authors proposed that the main problem in this patient was representing information about unique objects. It remains outstanding, however, whether the patient's representations were actually impaired or whether it was just a problem of access – the authors did not have the chance to investigate implicit memory for people in this patient. One cannot be sure, moreover, as the authors comment, that the damage in this patient was solely restricted to the right temporal lobe since the seizures may well have affected the left temporal lobe as well. Thus speculation on the neurological basis of the system for processing unique objects must remain uncertain here. The important conclusion, nonetheless, is that processing of unique objects (famous people, buildings, animals) is at least partially independent of processing of objects at other levels of abstraction (e.g. naming drawings of objects and making category membership decisions for objects).

Flude, Ellis and Kay (1989), presented a patient who had a left temporal or temporal-parietal tumour removed and suffered from a severe anomia. The authors tested the patient's performance on multiple aspects[11] of the Bruce and Young (1986) model of face recognition and reported that the patient performed within normal levels on familiarity ratings of, and occupation generation from, famous faces but was grossly impaired at the naming of famous faces. This was in the presence of good perceptual

[11] All except facial speech analysis, see Bruce and Young (1986).

processing of faces (on face decision, sex decision, expression matching and unfamiliar face matching). Furthermore, the patient performed well on semantic categorization of either famous faces (on both occupation and nationality) or famous names (occupation), and could correctly match spoken names to faces. Thus the central problem which this patient encountered in person recognition was a severely impoverished ability to generate the names of famous people, yet the patient could make decisions on the basis on names if they were provided. This pattern of results was a successful corroboration of the Bruce and Young model which predicted that patients should be found who have normal access to semantic knowledge about people alongside naming generation problems. The most important point from this study, in the present context, is that it shows the partial independence of name generation from most other aspects of person recognition, such as processing of semantic knowledge about people. Thus this is another useful constraint on models of person recognition.

Kay and Hanley (1999) re-examined a patient first reported by Hanley, Young and Pearson (1989) who suffered from herpes simplex encephalitis, with reported damage to the right temporal area. On tests of general semantic processing (e.g. Pyramids and Palm Trees test; Synonym judgement task) the patient performed reasonably well, though he did show some difficulties in a picture decision task (where the patient is shown a picture and the experimenter states three possibilities from which the patient must choose). Kay and Hanley further show that the patient's performance on living and non-living items on a confrontation naming task does not differ across these categories and further is intact. Kay and Hanley conclude the patient has a mild semantic memory impairment (as shown in the picture decision task). On tests of semantic aspects of famous person recognition, however, the patient was severely impaired (scoring at chance on a semantic name association task and at grossly impaired levels on both a name-face matching task and a serially presented face-name decision task). The authors argue, however, that as the majority of the patient's errors on the name-face matching task are semantic in nature the patient may well have intact implicit semantic knowledge about famous people. Thus this patient demonstrates grossly impaired semantic processing of famous individuals with relatively intact semantic processing of objects and words. Kay and Hanley's central point is that, contrary to what Hanley et al. (1989) claimed earlier, impairment of person-specific knowledge, in this case, does not go hand in hand with a general impairment in the processing of living things. Thus there would seem to be partial independence between semantic processing / representations in general and semantic processing / representations of famous people.

Indeed this conclusion is supported strongly by Kay and Hanley (2002) who present a patient that suffered from left hemisphere brain damage due to an infarct. Their patient showed normal performance on a wide range of tests involving famous person processing (person association tests, name-face and face-name matching tasks, face-occupation matching) but not for name generation (or for occupation generation). This performance contrasted markedly, however, with the patient's performance on tests of semantic processing of common nouns (e.g. picture naming, semantic association tasks, word-picture matching). The authors showed that the patient's preservation of famous person-specific knowledge did not extend to a general benefit for the processing of living against non-living things (on a picture naming task). Thus, in summary, this case provides strong evidence of the partial independence of famous person-specific knowledge representation / processing and that for general semantic processing of objects (common nouns).

In summary, the research reviewed above suggests a number of constraints on models of famous person recognition. Specifically, it suggests that the semantic representation (or processing) of famous people is at least partially independent of that for general objects. Further, within famous person recognition itself, the findings suggest that name generation is relatively independent from other aspects of person recognition, notably representation of semantic knowledge about people. Finally, research has shown that the semantic representation or processing of unique identity of famous objects is partially independent of the semantic representation or processing of objects in general. These are useful constraints with which to further delineate a theory of person recognition. One element missing from these studies, however, is a formal comparison of each patient's processing of personally familiar people with that of famous people. Do the constraints just outlined hold for both classes of known individuals? Is representation and processing necessarily the same for each class? I now review two studies which did include such a comparison.

Research carried out by Hodges and McCarthy (1993), and by Kitchener and Hodges (1999), included such a comparison. Hodges and McCarthy (1993) report a patient who experienced bilateral thalamic infarction.[12] This patient performed well on tests of famous person knowledge (generating specific semantic information from both faces and names) though he was impaired at naming of faces. The patient could also discriminate famous from non-famous items for both faces and names. Moreover, he performed in the normal range in discriminating the most recently or least recently famous person in a triplet of famous persons with the same occupation. This was despite the fact that he could not place individual names in the correct time frame. Thus the patient's performance on famous items was, on the whole, pretty good. This was in direct contrast, however, to his performance on both famous events, and for autobiographical memories in general.

The patient was severely impaired (more than four standard deviations below normal) on discrimination of famous true events from fictitious events, and on dating the events declared true (events were presented as names of news items, e.g. "the Watergate scandal"). Famous event knowledge was also severely impaired as assessed from photographic identification and by recency judgements. Thus, in contrast to the patient's good performance on tests of famous person knowledge he is severely impaired on tests of famous event knowledge.

The patient's memories of personally familiar people were also assessed by Hodges and McCarthy. Performance on photographic identification task of family members showed poor performance on identification of the people in the photos (35%). Further, identification of the events depicted in the photographs was non-existent. Other tests revealed a severe impairment of autobiographical memory in general.

The important points from this study are the following: first, processing of famous people does not necessarily go hand in hand with processing of famous events. Thus there is some degree of independence between the two sorts of items. One would not have necessarily expected this given the findings of Ellis et al. (1989). It would

[12] A stroke affected the thalamic area of the brain.

have been beneficial, moreover, if Hodges and McCarthy could have included some test of the patient's processing of famous objects for comparison to the Ellis et al. (1989) study described earlier since their patient may well have been able to identify such objects. Second, this study suggests that there may well be a dissociation between the processing of famous people and the identification of personally familiar people, with this patient performing much better on famous people.

Kitchener and Hodges (1999) presented a patient who demonstrated the reverse dissociation to that described above. This patient suffered from progressive deterioration of the right temporal lobe and was severely impaired on tests of famous person knowledge (on identification and familiarity detection for both faces and names and on recency judgements with names). Her performance on both the famous faces test and the famous names test had deteriorated substantially across a three-year interval (1992 – 1995). The patient's knowledge of famous events, moreover, was also extremely poor (as measured by the true / fictitious event task described earlier, by a familiarity detection task for more recent events, by event identification from photographs and names, and by recency ordering of famous events).

Tests of autobiographical memory, in contrast, showed good performance (she performed in the normal range on the Autobiographical Memory Interview and on a test of cued recall of events). An autobiographical name recognition and identification task, furthermore, was devised which consisted of personally familiar individuals from the patient's life alongside distracter items. The patient performed much better on this task than on recognition and identification of famous names. The patient also performed admirably on a test of cued recall of autobiographical events (featuring events in which the patient was directly involved, e.g. "Your holiday in Italy").

Thus this patient appears to perform well on tests of autobiographical memory (for both people and events) but poorly on tests of either famous person or famous event knowledge. The study strongly suggests the partial independence of processing and or representation of famous and personally familiar people. It thus supports the work of Hodges and McCarthy (1993). The patient of Kitchener and Hodges, in fact, demonstrates the opposite dissociation to that seen in the Hodges and McCarthy study. That is, Kitchener and Hodges' patient performs well on tests of personally familiar people but very poorly on tests of famous person knowledge. Hodges and McCarthy's patient showed the reverse profile: that is, much better performance on tests of famous person knowledge than on tests of personally familiar person knowledge. Thus these two studies then suggest the partial independence of the processing and or representation of famous persons and persons with whom one is personally familiar.

Kitchener and Hodges argue, moreover, that the reason for better processing of personally familiar individuals than famous individuals in their patient is due to personally familiar memories having greater multi-modal information. This allows easier retrieval of such information when compared to retrieval of famous person knowledge since there are more (distributed) cues with which to access the personally familiar knowledge.

Further, evidence from patients with Semantic Dementia, which is a progressive, relatively isolated loss of semantic knowledge arising from deterioration of the inferolateral area of one or more of the temporal lobes (e.g. Graham & Hodges, 1997), suggests that a dissociation between the representation of personally relevant (or familiar) people and famous people may well exist. Graham, Lambon-Ralph and Hodges (1997) presented two patients with semantic dementia who were significantly better at matching a first name to a surname (out of a choice of three) correctly when the name was that of a currently relevant person (who played sports with the patient) as opposed to either a current or past famous person. On a name identification task both of these patients were severely impaired compared to controls, but they did provide slightly more information on personally familiar people. Thus this is further evidence of an asymmetry in performance on famous and personally familiar individuals.

The studies reviewed in this section allow a number of important conclusions to be drawn about the broad outlines of the person recognition system and how it relates to the general cognitive system. Broadly, several studies suggest (Kay & Hanley, 2002, 1999; Kitchener & Hodges, 1999) that semantic processing of famous people can be selectively impaired relative to semantic processing of objects. It is not clear at present, however, whether impairments in these other systems would be seen if task requirements were equated with those for person recognition (i.e. unique identity level processing of objects). Furthermore, the study of Ellis et al. (1989) suggests the partial independence of unique identity processing of famous people, famous animals and famous buildings, from general semantic processing of objects.

With respect to outlining constraints within the person recognition system itself, Flude et al.'s (1989) study demonstrates, for famous people, the partial independence of name generation from most other aspects of person recognition, especially that of familiarity detection and semantic identification. The final two studies reviewed (Hodges & McCarthy, 1993; Kitchener & Hodges, 1999), moreover, suggest the partial independence between the representation and or processing of famous persons and persons with whom one is personally familiar.

Thus the set of constraints obtained for the theorist of person recognition is impressive. They are quite simply ways to reduce the dimensionality of our theories. I review and comment on other such constraints as and when natural throughout the present thesis.

1.3.2 Representation and Process

I now progress to consider some of the ways that have been suggested as plausible mechanisms for the representation and processing of semantic information. I consider first abstractionist theories, then instance theories and finally one hybrid theory of semantic representation.

1.3.2.1 Abstractionist or Strength Representations

All of the forms of semantic representation which I discuss in this subsection will be of the strength or abstractionist type. That is, for each concept, there will be only one node or unit in memory, or set of units in memory, which responds to that concept time and again. This contrasts with an instance-based view where each different experience results in a different trace being laid down, which is reviewed in the next section.

One of the first methods of representing semantic knowledge was the network model of Collins and Quillian (1969), later refined by Collins and Loftus (1975). I describe the theory as outlined by Collins and Loftus. This model consisted of *nodes*, where concepts were represented, *links*, which joined the nodes together, and *properties*, which were stored at each node. The links have different criterialities which specify how essential some link is to the meaning of the relevant concept (Collins & Loftus, 1975). The great advantage of this model was that it was efficient (see McClelland & Rogers, 2003). Properties belonging to a whole class of objects could be stored at the node representing the class (e.g. the properties *eats*, *breathes*, *moves* etc could be stored at the *animal* node) and would apply to all the concept nodes nested under as subclasses (e.g. bird, dog, fish, and so on). Thus the set of generic properties only had to be represented once, at the highest level, and this would then apply to all the nodes lower in the hierarchy. Exceptional properties (or idiosyncratic) properties would be stored with each individual concept node (e.g. that penguins don't fly and so on). Thus this mode of representation is efficient. Further, to verify that "A robin is an animal" on this view, the concepts for *robin* and *animal* would first be activated while a participant reads the question. Activation would then spread outwards from each node until an intersection is reached. If the summed activation at the point of intersection exceeds threshold then the specific paths traversed by activation originating from each original concept node are evaluated. A semantic matching process is assumed to occur and evidence (from different paths in memory) is collected so as to determine whether to respond in a positive or negative manner. Relevant evidence includes finding, or not finding, a superordinate connection between the two concepts (affirmative evidence of this kind is conclusive) and noting properties which match and mismatch between the two concepts (weighted by their criteriality to the target concept; that is, how important they are to the target concept). Evidence from sources such as these feeds into the decision process.

An important point about the semantic network model described above is that it employs localist representations, one node for each concept. Further, it supposes a process of activation spreading through related concepts in memory. In studies of associative and semantic priming the notions of localist nodes and spreading activation are still present (see e.g. Neely, 1991; McNamara & Diwadkar, 1996). Indeed, for many years now, activation spreading throughout nodes in a network has been one of the main explanations of associative / semantic priming. The explanation is simply that activation spreads from a prime word (e.g. doctor) to related concepts in the network (e.g. nurse) thus speeding responses to the second item (the network is organised according to semantic similarity) relative to the case where an unrelated prime is presented. Neely (1991) reviews several problems with spreading activation theories as theories of semantic / associative priming. These theories are still prevalent, however (see e.g. McNamara & Diwadkar, 1996). On the whole, these types of theory have had a tremendous effect on theorising on semantic memory. A major problem with such spreading activation theories, however, is that they do not specify the origin of the semantic structure presumed to exist (e.g. if the modeller organises his model due to semantic similarity; see also McClelland & Rogers, 2003).

More recent theories of semantic representation, in contrast to the spreading activation theories considered above, posit that the primary mode of semantic representation is highly distributed (e.g. McRae, de Sa & Seidenberg, 1997, and Masson, 1995, amongst others). In these models, semantic representations consist of a pattern of activation across a set of simple processing units, which may be thought of as representing the features of each semantic representation (though not necessarily one to one). To illustrate the way these models account for semantic effects, I will outline how Masson's model accounts for associative / semantic context effects. Simply put, the reason why priming is observed when making a lexical decision to, say *lion*, after just viewing the word *tiger*, is because these two objects share semantic features whereas an unrelated prime like *bush* shares much less features with *lion*. Since the related objects share many features the activation set which represents each of these objects in the network will be quite similar. Thus it is easier for the network to change its state from one word to a related word than it is to change from the same prime word to an unrelated word. This is the fundamental explanation of semantic / associative priming. One could conceivably explain associative priming in person recognition in an analogous manner.

Some researchers have recently begun, moreover, to unravel the internal structure of semantic representations (e.g. McRae, de Sa and Seidenberg, 1997; Devlin, Gonnerman, Andersen & Seidenberg, 1998; Tyler, Moss, Durrant-Peatfield, & Levy, 2000; Garrard, Lambon-Ralph, Hodges & Patterson, 2001). This is a critically important step. Previous theories have generally just used semantic representations hand specified by the experimenter with little empirical constraint. Newer distributed, connectionist, models, however, base their semantic representations upon representations obtained from participants' performance on property generation tasks.

McRae et al. (1997), for instance, have shown that their model, whose semantic representations are structured according to norm data, provides a good explanation of semantic priming and feature verification tasks. Their model is sensitive to both an individual feature representation for each concept and a correlated feature representation for each concept. In this context, correlated features refer to pairs of features which co-occur across basic level objects (McRae et al., 1997). An example would be that *breathes* and *eats* are correlated features because things which breathe also tend to eat (i.e. animals). The authors were able to show that the categories of living things and non-living things possessed different internal structure (see also Garrard et al., 2001). Living things consist of more correlated feature pairs than do non-living things and this affects the ability of each mode of representation (individual or correlated) to predict performance for each class of object on speeded semantic priming tasks. The important variable in predicting feature verification latencies, after a whole host of other factors were removed[13], was a measure called inter-correlational strength. This was defined as the sum of the shared variance between the target and each other feature within a given concept. Thus the work of McRae et al., amongst others, has highlighted the importance of investigating the internal structure of semantic representations and incorporating such structure into one's theories of semantics. Thus these models are a more constrained than those such as Masson's (1995).

The major problem with all the theories reviewed in this subsection, however, is that they do not explain how the semantic structure, apparent in the models, arises. This is a central issue for any strength based model of semantic representation: how are the representations initially formed and changed with experience? McRae et al.'s model comes closest to asking this, but although that model is constrained by empirical feature generation data it still does not explain how the structure of the semantic system arises. It is just a case of specifying the model's semantic representations as informed by the

[13] Including two measures of typicality.

norm data. There is no information here on how the semantic system might actually learn the semantics (see, however, McClelland & Rogers, 2003; Rogers et al., 2004).

1.3.2.2 Instance theories

In contrast to those theories of semantic representation just discussed there is another broad class of semantic knowledge representation. This involves representing separately each experience (instance) in the memory system. The structure apparent in semantic knowledge tasks is thought to represent the effects of retrieving pooled sets of experiences on the given tasks.

An example of a theory of this class would be that of Hintzman (1986; 1988). His Minerva 2 model specifies that each event which is attended to forms a separate trace in memory, and that repetition results in many traces which co-exist even though they may be initiated from the same source and may represent the same or similar things (see Hintzman, 1986). Thus, on an instance view, each experience leads to another memory trace being laid down. Structure within the memory system (there is no differentiation between the semantic and episodic memory systems on this view) is due to the effect of retrieving a set of memories in response to a probe item. Can such a system account for semantic priming? Ratcliff and McKoon (1988) have put forward a compound-cue theory of priming which can be implemented on Hintzman's (1986) instance-based model. Thus the basic result of semantic and associative priming can be accounted for on an instance view. The idea is that the prime and target on each given trial of, say a lexical decision experiment, form a compound cue which probes the memory system and the speed of response is determined by the familiarity of that compound cue. Familiarity will be higher for related trials (*tiger - lion*) due to the pre-existing association of these items in memory whereas familiarity will be much lower for unrelated trials (*book – lion*).[14] Neely (1991) reviews various theories of semantic /

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[14] Note that both semantic and associative priming should be explainable on this view. Associative priming is more straightforward since associations are stored directly in such models (e.g. if you see two people together then they will be represented in memory traces together). Semantic priming, however, is also explainable. Two semantic, but not associatively, related items will share common contextual features, which are also represented in memory traces (e.g. *lion – cheetah*).

associative priming and provides in depth criticism of each type, including spreading activation models and compound cue models.

Instance theories can successfully account for repetition priming and automaticity phenomena in memory (see Logan, 1988; 1990). Logan (2002) notes, moreover, that instance theories can account for classification, identification, and recognition tasks (citing the work of Nosofsky, e.g. 1988). Furthermore, Logan's most recent theory unifies previous theories in the domains of attention, memory and categorisation (Logan, 2002). Instance representation is used in this theory and the theory appears to account for a lot of data. Thus instance representation is clearly successful in several different fields.

There are problems, however, with this mode of representation. There are several experimental results which seem difficult to explain on this view. The existence of cross-domain repetition priming in person recognition appears difficult for an instance-based account to explain (see Burton, Kelly & Bruce, 1998). In the domain of word recognition and identification, moreover, there are also some troublesome findings for instance theories. For instance, there is the finding that repetition priming between different versions of Japanese scripts results in the same magnitude of priming as priming between the same version of each script (e.g. priming from "Kanji" to "Hiragama" is equivalent to priming from "Kanji" to "Kanji") [Bowers and Michita, 1998]. This finding was reported from a lexical decision task which is generally quite a shallow task, in terms of semantic processing. There is also equivalent repetition priming, in perceptual identification, when a target word is repeated in the same case as the prime and when it is repeated in a different case from the prime (e.g. DREAD – dread = dread – dread) [Bowers, 1996]. Importantly Bowers argues that these effects cannot be semantic in nature since when there is a change of modality from the prime to the target (e.g. visual to auditory) there is a significant decrease in the magnitude of priming relevant to the cases cited above. The implication being that any semantic effect should be the same in the cross-modal condition. Thus there certainly are some experimental results which pose problems for instance theories of representation.

1.3.2.3 Abstractions or Instances?

Instance theories thus differ from strength or abstractionist theories in that they propose that subsequent experiences of a given stimulus are represented in separate traces (e.g. Hintzman, 1986; Logan, 1988; 2002). Thus, whereas on the strength view if one views a given face several times the same representation will be accessed and modified each time (e.g. McClelland & Chappell, 1998), on the instance view a different trace would be created each time. This is the essential difference between the two modes of representation. Both modes of representation, however, allow for general and specific effects of prior experience. Proponents of the strength view do not state that abstract representations are the only mode of memory representation, rather they also allow for an episodic memory system. Hence these models can allow for both general and specific influences on experiments. The instance view, moreover, can also accommodate both general and specific influences. Clearly, since different experiences are represented separately effects of specificity can arise on an instance view. These types of model, furthermore, also can allow for general influences through the combined action of retrieving a set of memories. Thus, as may already be clear, testing between these two types of representation is difficult indeed. One thing, however, which can be stated with confidence is that episodic (instance) representations are necessary for the human memory system, no one argues about this point. The argument is over whether they are sufficient for human memory or whether another form of representation is required.

Logan (2002) argues that, on the grounds of parsimony, the instance view should be favoured since it assumes only one form of representation relevant to the two forms required by the abstractionist. This is certainly true but one must also contrast those instance theories which do assume something like a mechanism of abstraction during retrieval (class one instance theories e.g. Hintzman, 1986; 1988) and those which do not (class two instance theories e.g. Logan, 1988; see Komatsu, 1992, on this point). Logan (2002) wants both to use Hintzman's work as evidence for the instance approach while at the same time arguing that instance theories require no mechanism of abstraction. Some instance theories do utilise something like a mechanism of abstraction during retrieval. Thus those instance theories which assume no mechanism of abstraction during learning or retrieval are more parsimonious than abstractionist theories and thus more falsifiable. On the other hand, those instance theories which assume a mechanism of abstraction during retrieval are not necessarily simpler than abstractionist theories which assume an equivalent mechanism works during learning. These latter instance theories, however, are simpler than abstractionist theories in only requiring one form of representation, but have been challenged on the grounds that if one is going to assume a mechanism of abstraction at all then it is non-parsimonious to not assume it occurs during learning (Schank, Collins and Hunter, 1986; Oden, 1987 [both cited in Komatsu, 1992]). Thus the degree of parsimony of the latter type of instance theory is open at present. Considerations of parsimony then are not going to resolve this debate at present.

If one investigates the types of model that account for various phenomena across diverse areas of cognition one finds that, in person recognition, strength models rule the day (e.g. Burton et al., 1990; Bredart et al., 1995). In word recognition, both types of representation seem to be required (see Tenpenny, 1995 and the rejoinder by Bowers, 2000). In the field of categorization instance theories do seem to be favoured on the whole (see Logan, 2002, but see Komatsu, 1992). Logan (2002), as mentioned earlier, presents an instance-based model of attention, categorization and automaticity which integrates these different areas of research. If one looks at models of semantic memory, in contrast, the representations are nearly always strength-based (see e.g. Masson, 1995; McRae, de Sa, & Seidenberg, 1997; Collins and Quillian, 1969). It is an interesting question whether instance based models could predict the differences in priming between different categories of objects. Thus it seems that across diverse areas of research some times instance theories are preferred whereas other times strength theories are preferred.

An important point, in any case, made by Anderson (1990) is that any number of different mechanisms can achieve a given function and are thus equivalent with respect to some set of data. Thus to test out theories we may have to look at a higher level of analysis than just mechanism. The implication here is that, for a given set of data, one could construct both an instance-based model and a strength-based model which would be equivalent. This is why Anderson (1990) argues that we must move to a higher level of theorising rather than just the mechanistic level. It is an open question, furthermore, to what extent the proponents of the aforementioned models actually have sound theoretical reasons for using either abstractionist or instance representations.

1.3.2.4 Evaluation

There is no easy answer to the debates alluded to in the last section. One point in favour of instance theories is that they seem to be able to cope with learning easily whereas many strength theories do not. On the other hand, as noted by McNeill (2002), strength theories allow for some essential features of human cognition, such as productivity. This has not been demonstrated to date for instance-based theories, although it would seem to be possible, in principle, for such theories. I think that the best approach, at present, is to follow that of Anderson (1990), and thus try and have the mode of representation being stipulated by higher levels of theory. Additional constraints, moreover, may be obtained from considering the neurological bases of human memory. I consider, in the next section, a neurologically inspired model of human memory.

1.3.2.5 A Neurobiological, Hybrid, Theory

Nadel and Moscovitch (1997; Nadel, Samsonovich, Ryan & Moscovitch, 2000) have developed a model of the neurobiological processes of memory formation and retrieval which has much relevance to the type of the models I have discussed until now (i.e. instance based and abstractionist). Their model, called the multiple trace theory (MTT), is a counter to the standard model of memory consolidation (see e.g. McLelland et al., 1995). The authors explicitly differentiate the neural mechanisms assumed to underlie episodic and semantic memories, whereas the standard model fundamentally treats these two types of memory the same way. Episodic memories, in Nadel and Moscovitch's view, *always* require the activation of both the hippocampal complex and the neocortex for retrieval, whatever the age of the memory. Semantic memories, in contrast, are initially dependent upon the hippocampal complex plus the neocortex but with time (and repeated instantiation) can be retrieved solely by use of the neocortex. The standard model, however, assumes that both episodic and semantic memories initially depend upon both the hippocampal complex and the neocortex but that with time both types of memory can be retrieved solely through neocortical activation.

The assumptions of Nadel and Moscovitch (1997) are also worthy of examination. This is especially important in order to understand their view of semantic extraction from episodic traces. First, they propose that the hippocampus encodes the elements of any part of an experience which is attended to, and further bind the elements of the event together into a memory trace. The hippocampal representation itself acts as a *pointer* to the neocortical neurons which represent the features of the experience. The episodic representation for an event is the hippocampal – neocortical ensemble. These assumptions are, according to Nadel and Moscovitch, shared with the standard model. Where they differ is in the following. Each reactivation of such a memory is assumed to lead to a new trace being formed. This new trace will share much information with the original. This process of multiple trace creation, for the same initial *memory*, is argued to aid both the extraction of semantic information from these traces, and integration of the new semantic information with other semantic memories. Nadel and Moscovitch propose that semantic information, which is often initially acquired within an episodic experience, becomes independent of the latter with time. Hence semantic memories are, with time, fully represented in the neocortex and are retrievable solely by that means. Retrieval of episodic memories, however, always requires both the hippocampal complex plus the neocortex (and possibly also the frontal lobe).[15]

Thus Nadel and Moscovitch propose a system of memory organisation and processing which differentiates explicitly between semantic and episodic memories. The key question, however, is how exactly does the semantic information become separated from the episodic representations and represented independently in the neocortex? Nadel and Moscovitch (1998) argue that it is a general assumption of researchers in this area that many semantic memories arise out of a series of episodic memories. This, they note, however, is not the full picture. Nadel and Moscovitch (1998) cite both the case of infantile amnesia and that of temporal lobe amnesia – in

[15] The authors argue that the hippocampal complex is necessary for spatial context and the frontal lobe for temporal context.

both these cases the episodic memory system is not functioning yet semantic learning is possible. Thus semantic memory creation does not, of necessity, require the episodic memory system.

The specific mechanism of semantic memory creation is not specified in much depth by Nadel and Moscovitch (1998). They do, however, outline it in general terms. The episodic ensemble memory trace (hippocampal-neocortical trace), when reactivated, serves to strengthen the links between the different areas of neocortical representation. With sufficient time, and hence strengthening, the neocortical representation becomes fully independent of the neocortex. This is how semantic knowledge is formed from episodic memories, on their model. Thus, in summary, the multiple trace theory of Nadel and colleagues is a hybrid theory which explicitly speaks to both semantic and episodic memory representation and processing, and further, to the interaction between the two types of memory.

This suggests some interesting questions for theorists of memory who work at the functional level. First, are instances the same as episodes? Episodic memories are commonly differentiated by the spatial and temporal context present in such memories. Tulving (2002) has suggested, furthermore, that the key distinguishing feature between episodic and semantic memories is the ability to be able to re-experience an episodic memory (that is, the autonoetic component of such memories, which allows one to mentally time travel, so to speak). Are all instances episodic memories in this sense?

Second, Nadel and colleagues highlight cases where the episodic (and instance?) system is not working yet new semantic learning is possible. If instance theorists posit that instances are episodes (in the above sense) then how does the semantic system learn in the absence of new instances, on the instance view, or even on the strength view for that matter? This, I think, is a very important question. If it is possible for the semantic system to learn without episodic (instance?) input then what is to stop this type of learning being the standard way of learning in the semantic system?

Thus even brief consideration of models of memory which are neurologically inspired has highlighted some interesting questions for functional models of memory. More dialogue between the two levels of theorising is required.

1.3.2.6 Conclusion

Perhaps, then, what are needed at the functional level of theorising about memory are models which specify both semantic and episodic memories and their interaction. Both strength and instance-based models suffer from some serious problems which need to be addressed but, more fundamentally, theories of semantic representation need to be more heavily constrained (both by higher levels of theory and by neuroanatomical evidence). Of course, abstractionist theorists do not deny the existence of episodic memories and as such a focus on the development of semantic structure may lead to unification of semantic and episodic memory representations since it seems that semantic structure is taken to, on many occasions but not all, evolve out of episodic memories. Thus a focus on semantic learning may lead to a synthesis of the different types of representation proposed for semantic knowledge, or it may lead to the demonstration that only instances are required. In the present thesis I will derive theoretical explanations from models with either type of representation in light of which can best account for the given data. After this long, important, digression into the field of semantics I move now to consider the processes of person familiarisation.

1.4 Familiarisation

In this section I review some research which highlights why the process of familiarisation is important. I first establish that differences exist in the processing of familiar and unfamiliar people (relying on evidence from research on face processing).[16] Second, I attempt to provide an initial explanation of such differences. Third, I review the scarce research that has investigated the processes of familiarisation itself. Fourth I review some explanations of different elements of the familiarisation process.

[16] I rely on evidence from face processing due to the profusion of research in this area compared to that for names or voices.

1.4.1 On the difference in processing familiar and unfamiliar faces

In this section I selectively review some notable differences in the processing of familiar and unfamiliar faces across both perceptual and more memory-based tasks. This distinction of perceptual and memory-based tasks is not all or none but one of degrees.

1.4.1.1 Perceptual Tasks

There are many differences between the processing of familiar and unfamiliar faces (see the review by Hancock, Bruce & Burton, 2000, which focuses on *unfamiliar* face processing). Much of the following will be concerned with internal and external feature processing on perceptual matching tasks. Internal features refer to the eyes, nose and mouth whereas external features refer to what is left if we remove the internal features, that is the chin and hair, and face outline. I note at the outset that in these tasks there are two main comparisons which can be made. The first regards between class (of faces) comparisons on the same perceptual feature (e.g. comparing familiar and unfamiliar face processing on internal features). The other pertinent comparison is an initial within class comparison on the same class of face (familiar or unfamiliar) with respect to the different types of perceptual feature (e.g. comparing familiar face processing on internal versus external feature processing) followed by a between class comparison of the patterns obtained for each class. Both types of comparison can shed light on possible familiar / unfamiliar processing differences.

Young, Hay, McWeeny, Flude and Ellis (1985; Experiment 1), for instance, asked participants to match both familiar and unfamiliar faces on both internal and external features of the face. Participants had to judge whether two faces presented simultaneously were of the same person or not (one face was always presented in whole face format whereas the other was either presented in internal or external format). Importantly when the two faces were of the same individual they were always different images (thus ruling out a simple image matching strategy). Young et. al. found responses to familiar faces were made faster than responses to unfamiliar faces for internal feature matching but that there was no difference for external feature matching (this held across both *same* and *different* responses). With respect to accuracy, participants were most inaccurate when matching two "same" unfamiliar faces (accuracy did not differ across the other conditions).[17] For unfamiliar faces, moreover, external feature matching was faster than internal feature matching whereas the same comparison for familiar faces was equivalent (this holds when pooled across both *same* and *different* responses but whether it holds individually is not made clear by Young et al.).[18]

Thus there is evidence of differential responding to familiar and unfamiliar faces. Familiar faces seem to be matched more speedily on internal features than unfamiliar faces are, and, in addition, unfamiliar face matching A) across *different* images of the same person was found to be less accurate than the equivalent familiar condition and B) was faster for the external relevant to the internal format (when pooled across *same* and *different* responses). Young et al. in their Experiment 2 showed that if the two faces to be matched were both from the same image then the differences due to familiarity were no longer present (in this case participants appear to use an image matching strategy and for both sets of faces there was an advantage for the external features in this case).

Clutterbuck & Johnson (2002), moreover, extended the work of Young et al. (1985) by looking at the effects of familiarity on a more graded basis, having a *familiar*, a *moderately familiar* and an *unfamiliar* set of faces but using the same kind of matching task as Young et al. This work replicated the main finding of Young et al.: namely that participants are faster to match two images of a familiar relevant to an unfamiliar face on the basis of the internal features (familiar < moderately familiar < unfamiliar; across both *same* and *different* responses). There was also a familiarity effect on accuracy though the specific pattern is somewhat different (familiar = moderately familiar > unfamiliar). For external feature matching, on the other hand, the authors report no latency difference between matching two images of the "same" person, across familiar, moderately familiar and unfamiliar sets of faces (a latency

[17] This is not particularly surprising since here participants have to try and visually match two distinct images of the same unfamiliar individual, with no knowledge of how the individual "looks" across differing images (see Hancock, Burton & Bruce, 2000, for a review of unfamiliar face processing).
[18] Young et al. do comment in the discussion of their paper that "it took longer to match unfamiliar faces on internal than external features". Since the statement is without any qualification this suggests that the difference held across both types of response.

difference does emerge on *different* responses, however, and the pattern on accuracy is less clear). Thus this work essentially replicates that of Young et al. (1985) and demonstrates a pertinent difference between the processes of matching familiar and unfamiliar faces, namely the internal feature benefit for matching familiar faces.[19] Furthermore, this data set also suggests that, for at least highly familiar faces, there is a trend towards an advantage of the internal over the external features.

Bruce, Henderson, Greenwood, Hancock, Burton and Miller (1999), used an array matching task to examine unfamiliar face processing. Their relevant experiment (Experiment 4) involved participants matching an unfamiliar target (colour video still) to one of several unfamiliar images present in an array (each a high-quality photograph). The authors manipulated which part of the face was viewed in the target images (whole, internal or external) and found that whole face images resulted in better performance (i.e. greater accuracy) than external feature images, which again were better than internal feature images. Thus, on an array-matching task with unfamiliar faces, the external features were found to be easier to match than the internal features, which, as Bruce et al. note, is in agreement with the external feature benefit for unfamiliar faces reported by Young et al. (1985). Thus, for unfamiliar faces, the external features appear to be better processed than the internal on accuracy as well as on latency.

O'Donnell and Bruce (2001; Experiment 1), moreover, have attempted to investigate the process of face familiarisation itself. In the initial training phase of their two experiments participants were shown video clips of several faces in motion (one at a time) and had to associate a name to each of the faces. Name to face learning was tested in a name verification task and participants had to reach perfect accuracy before progression to the test phase (thus several repetitions of the learning phase may have occurred for each participant). In the test phase participants had to judge whether two simultaneously presented faces were "physically identical" or not (on critical trials the two faces were of the same identity). Some of the test faces were the faces that

[19] Clutterbuck and Johnson (2003), however, do not consider the other pertinent comparison in their data – that is, the comparison within a given class of faces (familiar, moderately familiar, unfamiliar) of the different feature types (internal, external). From their data it does look, nonetheless, that the external feature benefit for unfamiliar faces may well be present on latency, especially for *same* responses.

participants had been trained on and some were unfamiliar to participants. At test, of the two images presented, one was always an unchanged face image and the other a changed face image (both presented in full-frontal format). Changes (either spacing or feature swaps) were made to the eyes and mouth (internal) and to the chin and hair (external). The authors found that eye changes were detected significantly better for the familiar than for the unfamiliar faces, in both experiments. Moreover, detection of changes to the hair was highly accurate for both familiar and unfamiliar faces, in both experiments. Thus again, differences between perceptual processing of familiar and unfamiliar face processing exist, and this study suggests that the internal feature benefit for familiar relative to unfamiliar faces may be largely due to enhanced sensitivity to the eyes for the familiar faces. The data from this study, moreover, show that external feature changes could be detected quite well by the unfamiliar group (i.e. better than internal features).

Bonner, Burton and Bruce (2003) also attempted to examine the processes of face familiarisation but these authors used a feature (internal or external) matching task to tap performance across three days of learning. The authors familiarised a group of participants with the same set of faces on three consecutive days and participants performed a matching task prior to the familiarisation period on day 1, but subsequent to that period on the latter days. The familiarisation period, in this study, consisted of participants watching a 30 s video clip of half of the faces in motion and a 30 s video clip of the other half in static mode (counterbalanced across participants). I will discuss only the results for *different* responses with respect to accuracy.[20] These authors report that prior to any learning (i.e. day 1 of testing) there is a benefit for external feature processing with respect to internal feature processing for the to-be-familiarised faces. By day 2, however, accuracy is equivalent across the internal and external features for the familiarised faces (across both the moving and static learning conditions). For

[20] The only result with the internal features on *same* responses was that internal features matching was better on faces learned in motion compared to unfamiliar faces. One has to ask, however, why no difference was found for the static learned faces when compared to the unfamiliar faces with respect to the internal features. Thus the pattern on the *same* responses is unclear. The above effect, moreover, does not interact with the day of learning and thus should hold on the three days of testing. This again seems strange. If I have interpreted the results correctly this means that there is already an advantage matching the internal features on faces that have yet to be learned since day 1 is a baseline measure taken when participants are unfamiliar with all faces.

unfamiliar faces, however, no significant difference is reported on accuracy between internal and external features on day 1, but one emerges on the latter days in favour of the external features. This is surprising since much previous research would have led one to predict an external feature advantage in this case on day 1. There is, however, a trend in the correct direction for this comparison. Thus three minutes (two learning sessions) seems to be enough familiarisation time for internal feature processing to improve to a comparable level with the external features. This pattern of equivalence across internal and external feature processing is the pattern normally found for familiar faces by Young et al. (1985).

On response latency, a benefit of familiarisation, on both *same* and *different* responses, was found for each day in turn (across both moving and static and internal and external features; day 3 < day 2 < day 1). For the unfamiliar faces only the day 3 against day 1 comparison was significant, perhaps being due to task familiarity. In summary then, Bonner et al.'s study demonstrates that the internal features are on a par with the external features after brief periods of familiarisation (three minutes per face) and in addition, partially replicates the work of Young et al., O'Donnell & Bruce (2001), and Bruce et al. (1999) with respect to the initial external feature benefit for the to-be familiarised faces.

Thus it seems clear that there are differences in the processing of familiar and unfamiliar faces and that the internal features appear especially salient for familiar faces but not so for unfamiliar faces (where the external features are at an advantage). More recent work by Bruce, Henderson, Newman and Burton (2001; Experiment 1) examined the aptitude of both a familiar and an unfamiliar group of participants in matching pairs of faces, one from a close circuit television (CCTV) video clip and the other a high quality still photograph. The authors found that familiarity with the faces had a large effect, on accuracy, in all their conditions (that is, there was a large effect of familiarity when either or both of the two comparison items were familiar). Further the effect of familiarity was mostly due to increased discriminability (in terms of signal detection theory). This fits well with the theory of McClelland and Chappell (1998) who suggest that what happens during familiarisation is that participants become better at discriminating the familiar items through a process of 'differentiation'. (I shall elaborate on this shortly.)

In their second experiment, the authors familiarised one group of participants with one set of previously unfamiliar faces, by giving participants a pre-test learning phase for these faces (either of 30 s or 1 minute video clips of the faces in motion). They then compared performance for these "trained" faces with a second unfamiliar set (which received no training) and found that performance on a matching task was non-significantly different across the "trained" and non-trained sets of faces (participants matched a video still to a high quality photo image here). Thus simple, brief perceptual familiarisation did not cause the familiarity effects, seen in their Experiment 1, to arise. In one condition of their third experiment, however, participants were given a training period in pairs and told to discuss the faces as they viewed them (the "social exposure" condition) and when later tested, effects of familiarity arose here (using an array matching task). Thus when the faces were processed "deeply" during the learning phase, the effects of familiarity seem to occur, even at short presentation times of each face in the learning phase (the training clips lasted roughly 28 s in this experiment and were viewed once). Bruce et al. (2001) conclude that it is the *type* of processing that one engages in, in the familiarisation period and not the length of that period that is most relevant to the establishment of the familiarity effects seen in their first experiment. I note, however, that this effect has failed to replicate and as such should be treated with caution (V. Bruce, personal communication).

Thus we have more evidence of a difference in the processing of familiar and unfamiliar faces on perceptual tasks. I now turn to evidence from memory-based paradigms.

1.4.1.2 Memory Tasks

Bruce (1982; Experiment 1) found, in a recognition memory paradigm, that for unfamiliar faces, changing either expression or pose angle of the face between study and test, decreases both recognition accuracy and recognition latency relative to the case where the same image is presented at study and test. Further, Bruce showed that if both types of changes were made then performance was worse than if only one change had been made. This suggests that performance for the unfamiliar faces on this task could be accounted for by a simple additive model. In her Experiment 2 she compared performance for familiar and unfamiliar faces with either no change or both the previous changes made between study and test. Performance on the familiar faces was more accurate and faster than for the unfamiliar faces in both conditions. Moreover, the changes had a large decremental effect on accuracy for the unfamiliar faces but none at all for the familiar faces, relative to the no-change case (Bruce notes that a ceiling effect may be responsible for the failure to find a difference here for the familiar faces). On response latency, interestingly, an effect of the changes does appear for the familiar faces (and of course it is also present for the unfamiliar faces) which suggests that there is some cost in processing a different image of the same familiar person. Thus we have evidence that familiar and unfamiliar faces are processed differently in a recognition memory paradigm, with familiar faces being processed more accurately and more speedily than unfamiliar faces, and in addition with processing being better able to survive image changes than for unfamiliar faces.

Moreover, Ellis, Shepherd and Davies (1979) found advantages for the recognition and identification of famous faces from the internal features in comparison to the external, whereas for recognition of unfamiliar faces they found no advantage for the internal features over external.[21] Thus in recognition tasks the internal feature benefit for familiar over unfamiliar faces also arises although there is no corresponding benefit on recognition of the unfamiliar faces from the external over the internal features (as found by various authors cited above). Importantly in the recognition experiments reported here the three versions (internal, external, whole) of the same individual were from the same photograph which is different to the studies above which used different images of the same person (e.g. Young et al., 1985). This factor then could explain why the external feature benefit does not arise in Ellis et al.'s recognition experiment for unfamiliar faces.

Using a different tack, Roberts & Bruce (1989) demonstrate that repetition priming of unfamiliar faces is different from repetition priming for familiar faces. They

[21] Interestingly Ellis et al. (1979) found that on identification there was an advantage for the whole face over the internal features for famous faces, but this did not occur on recognition, for the famous faces.

used a continual decision paradigm ("does this face belong in the target set?") where a response is required to every item presented. Manipulations were whether the repeated face was presented in the same view or not and the spacing of the repetitions (with a lag of either 0 or 1 intervening items). The authors found that for their familiar group (consisting of participants who were personally familiar with the faces used in the experiment), repetition priming was found for spacings of both 0 and 1 intervening items for both the same view and the different view. Thus repetition priming for the familiar faces seems robust to all the manipulations in this experiment (there are differences in terms of absolute response latencies to these manipulations but not to the amount of priming observed). There is, however, a slight discordance here with the result of Bruce (1982) who found an advantage of same view over different view in a recognition memory paradigm. The reason for the discrepancy is unclear.

For the unfamiliar group, on the other hand, repetition priming was only evident when the same view was utilised though it did occur for the same view at both lags. Thus utilising a quite different task to those detailed above, differences between the processing of familiar and unfamiliar faces abound. Familiar faces survive changes of view in repetition priming whereas unfamiliar faces do not.

1.4.1.3 Conclusions from the foregoing

We can now draw some preliminary conclusions regarding the processing of familiar and unfamiliar faces. I will first comment on between class comparisons before within class comparisons. On recognition, familiar faces are processed more speedily and more accurately than unfamiliar faces. On perceptual matching tasks, moreover, familiar faces are matched much more speedily on the internal features than are unfamiliar faces with no notable difference in external feature processing. Turning now to within class differences for familiar faces, in recognition accuracy is still high despite changes in view or expression from the learning phase to the test phase (and repetition priming occurs across different views). For familiar faces, there seems to be an advantage of the internal over the external features for recognition memory and identification, but not generally in perceptual matching. In contrast, processing of unfamiliar faces is image-specific and task performance drops off considerably across changes in view or expression in recognition and across views in repetition priming. On perceptual matching tasks, external features are matched better than internal features. Recognition, however, is perhaps no better from the external as from the internal features for unfamiliar faces. (This latter difference between perceptual matching and recognition *may* be due simply to the fact that in the perceptual matching tasks different images of the same individual were to be matched whereas in recognition the same image was presented at learning and at test, perhaps reducing any external advantage for the unfamiliar faces here.)

These main findings are readily explainable if we consider some general points from models of human memory (see e.g. McClelland & Chappell, 1998). First, the processing of unfamiliar faces is highly image specific as we only have a small amount of experience with these faces (that is, from the first presentation of the face during the task). For the familiar faces, on the other hand, we have a great number of experiences across differing contexts. Thus it seems plausible that familiar face processing would survive changes in image or view whereas unfamiliar face processing would not (since we have experience of familiar faces across a variety of views and contexts, and thus a more robust representation). Moreover, the fact that familiar faces tend to be processed more accurately and more speedily than unfamiliar faces is also explainable on this same view. Familiar faces, since we have more experience of them, are more *differentiated* which means that we can discriminate them better than unfamiliar faces (see McClelland & Chappell, 1998, reviewed in section 1.3.4), leading to the accuracy benefit observed for the familiar faces. In addition, more experience of almost any item means that on the next encounter speed of processing will be faster until some upper limit is reached (see Logan, 1988). The "differentiation" theory of McClelland and Chappell would seem to be able to account for most of the non-perceptual differences in familiar and unfamiliar face processing with respect to accuracy. The latency data could be modelled by a number of approaches (e.g. Logan, 1988; Anderson, 1990).

The internal feature benefit for familiar relevant to unfamiliar faces is also explainable on this view. Consider that for a familiar face the internal features are what change less over the multiple presentations of the faces of people we know well in comparison with the external features (Young, 1984). Another possible explanation for the internal feature benefit suggests the effect is due to social attention (see Ellis et al. 1979; O'Donnell & Bruce, 2001). When we interact with a face, these authors suggest, it is the internal features which we mostly pay attention to. Thus either of these explanations, or indeed both, could explain the internal feature benefit for familiar over unfamiliar faces. Furthermore, either of these views would lead to more differentiation of the internal as opposed to the external features for familiar faces over time and thus McClelland and Chappell's (1998) theory could explain the benefit, in principle. An unfamiliar face, in contrast would not be differentiated in terms of the internal features.

For unfamiliar faces themselves, it has been found that external features are better matched or more speedily matched than the internal (Young et al., 1985; O'Donnell & Bruce, 2001; Bruce et al., 1999). I think this is merely an artefact of poor internal feature processing for such faces. If we only have one or two presentations of a face then the external features will most likely be the better cue to identity. The external features of the face are generally more distinctive than the internal and thus can be a powerful cue to identity, but they are more variable than the internal (across the same person at different times) and thus are not of as much use as the internal features for determination of identity in the future, unless the given individual's external features never change (which seems highly improbable).

For familiar faces, an internal feature advantage (over external features) is reported for recognition and identification (Ellis et al., 1979) but not generally for matching. That there is an advantage for recognition memory[22] and identification can also be explained as due to the differential differentiation of the internal and external features of a familiar face over time.[23] The interesting point here is why this pattern is

[22] In the relevant recognition memory study of Ellis et al. (1979) even though participants saw the whole face image at prime and either the internal or external features of the *same* image at test the internal benefit still emerged for the familiar faces. I presume this result occurs since it is easier to recognise a familiar face from its internal features than its external features if one is doing so from memory (i.e. not with the two images side by side as in matching tasks). Perhaps it is the internal features of a familiar face that a participant naturally gravitates to when viewing a whole face in the prime phase of such an experiment.

[23] Why Ellis et al. (1979) found an advantage for the whole face over the internal features only for identification and not recognition is not clear on this view. Presumably it is easier to identify someone from their whole face as this contains more information than merely the internal features alone. Perhaps the reason the whole face advantage did not occur on recognition has to do with the fact that the same

not usually seen for matching tasks. The reason, I think, is due to the differing task demands. To match one has both stimuli present and thus, so long as differences in external features are not too large, either feature will be matched well for a familiar face. In recognition and identification, in contrast, the use of memory is most critical. Where use of memory is pronounced then the internal feature benefit will arise prominently (from being better represented etc). These results then are also explicable on the model of McClelland and Chappell (1998) and hinge on the different levels of differentiation of the internal features for familiar and unfamiliar faces.

The one effect which the current theories may have more problems explaining is the effect of "social exposure" on increasing performance on the array-matching task for briefly presented unfamiliar faces to the level seen for familiar faces. However, since this effect has only been reported once, and has failed to replicate, it should be treated with caution. Nonetheless, semantic knowledge needs to be part of any complete model of the familiarisation of people, and in this regard, McClelland and Chappell's (1998) model is mute. A more recent model, however, reported by Rogers, Lambon Ralph, Garrard, Bozeat, McClelland, Hodges and Patterson (2004) considers specifically the formation of semantic knowledge and as such would most likely be more useful in accounting for any semantic effects which occur during familiarisation. I will discuss this model in more detail in the general discussion to chapter 4.

Now that I have established, clearly, that there are significant differences in the processing of familiar and unfamiliar faces across a variety of tasks, I move to consider the process of familiarisation itself. What happens to make an unfamiliar person familiar?

1.4.2 Familiarisation of new 'people"

As noted by O'Donnell and Bruce (2001) most studies investigating the differences in the processing of familiar and unfamiliar faces compare performance on completely unfamiliar faces (prior to the experiment) with a highly familiar set of faces, such as famous people or staff in a department. These studies tell us nothing of what

image was used in each recognition phase and possibly if a different images were to be used in each phase then an advantage of the whole face may also arise on recognition.

occurs during the transformation of a face (a person) from being unfamiliar to being familiar and perhaps highly familiar (i.e. the process of familiarisation itself). This is the starting point of O'Donnell and Bruce who are concerned, however, with perceptual familiarisation. They investigate what happens perceptually when faces change from being unfamiliar to familiar (as do Bonner et al., 2003). Equally important, however, is semantic familiarisation, which has not been considered much by researchers in this area (though see Bruce et al. 2001) unless we mean by semantic familiarisation some kind of depth of processing manipulation (see Bower & Karlin, 1974). We must not forget that for highly familiar people, representations of these people will be well developed both in terms of perceptual and in terms of non-perceptual knowledge.

1.4.2.1 Perceptual familiarisation

In studies that have investigated familiarisation, previously unfamiliar faces seem to behave as familiar faces, at least in perceptual terms, after relatively little exposure. O'Donnell and Bruce (2000) report training their participants on 20 s video clips. However participants were allowed to view as many presentations of these clips that they felt were sufficient prior to completing the name verification task (and possibly many times afterwards in order to meet the training criterion). The authors report that a benefit for the eyes (internal feature) emerges after this unspecified amount of training (estimated by O'Donnell, personal communication, to be on the order of about six minutes per face).

Bonner et al. (2003), moreover, demonstrated an improvement (on *different* responses) in matching the internal features of newly learned faces after an exposure duration of three minutes per face. Would, however, the effects of repetition priming found by Roberts and Bruce (1989) for familiar faces occur after these amounts of training or for that matter the differential effects of recognition memory established for familiar faces?[24] These are open questions. Before we accept that newly learned faces are

[24] One would assume that the effects of familiarity seen in the perceptual matching tasks reported earlier (e.g. faster matching of familiar faces on the internal features) would occur (after the training in the O'Donnell & Bruce study) since the benefit for the internal features already shows through on another task, provided that participants can recognise the target across the different images used. One might assume that the effects in recognition memory and repetition priming would therefore also hold provided the participant can recognise the relevant images across different views but this is an open point at present. It may well depend on the nature of the experience the participant has in the learning stage. It

behaving in the same way as highly familiar faces we should require confirmation across other paradigms of research, such as recognition memory and repetition priming. Does, for instance, having a knowledge representation (non-perceptual) facilitate performance on these kinds of tasks?

One rather serious problem with both of the above studies is that the training materials used in each consisted in simply repeating a 20 s or 30 s video clip of a face in motion or in static mode. Clearly the variation that participants are being exposed to here is minimal compared to that in the comparable situation in real life. In real life we don't usually learn from such constrained information. Thus it could be argued that even the perceptual effects obtained in the above studies may differ with a greater amount of variation during the learning stage. This is clearly important for future work to consider.

1.4.2.2 Semantic familiarisation

Semantic familiarisation involves learning a collection of knowledge pertaining to some individual. An initial knowledge representation may take the form of, "I saw that face in the experiment just before" or "this is the face of Bob", if one learns this in the training phase of some experiment. However, a complex knowledge representation for someone we know well will contain a vast array of details about that person (for instance what the person does for a living, where you usually encounter them, who are they married to or dating and so on). Thus while perceptual familiarisation is no doubt important, semantic familiarisation is no less so. The task of face recognition (which entails that of face perception) is, let us recall, to retrieve knowledge concerning a given face (see Bruce, Burton & Craw, 1992): firstly is this face someone I know, if so, what knowledge about them is relevant to this current situation, if not, do I need to interact with them. Perceptual familiarity with a face may be important, but in the real world, just being able to say "I recognise that face", even with high confidence, is of limited use in terms of successfully interacting with known people, which is one of the main purposes of face recognition (and hence person recognition). Perceptual

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may be that participants would be able to perform recognition memory and repetition priming across different views where both views form part of the training set but what about transfer to novel views? And what of the effect of a well-developed non-perceptual knowledge represenation on these processes?

recognition may be a stage on the way to semantic knowledge retrieval but it is only a step on the way.

Thus if it is claimed that familiarisation of faces occurs in some small amount of time, we should remember that it is depth of knowledge which is still lacking from these representations (that is, on some perceptual tasks the faces may behave like familiar faces, but in terms of knowledge representations, these faces are greatly impoverished) in comparison to our representations for "real-life" familiar people. Thus in their semantic form the representations of these "learned" faces are only at a rudimentary level. (Recall or associative priming tasks are, of course, a way to examine the development of semantic representations.) In the laboratory one can dissociate the processes of perceptual and semantic familiarisation to some extent, but in the real world these processes are intimately linked (see the neuropsychology work reviewed below), and concurrent. When examining studies of familiarisation we should bear these points in mind. It is an open question to what degree having a well-developed non-perceptual knowledge representation aids in completion of perceptual or memory based tasks for newly learned faces in normal participants. Some research on this topic has, however, recently been completed in neuropsychology.

This work, by Graham and colleagues (see Graham, Simons, Pratt, Patterson & Hodges, 2000; Simons, Graham, Galton, Patterson & Hodges, 2001; Simons, Graham & Hodges, 2002) studies the processes of recognition memory in patients with *semantic dementia*, which is a disorder characterised by a progressive deterioration of the inferolateral portions of the temporal lobes (see Simons et al., 2001). Patients with semantic dementia experience a profound degradation of semantic knowledge (see references cited in Simons et al., 2001). In the work cited above the authors demonstrate that successful recognition memory across perceptually different images of the same object or face depends upon the integrity of semantic knowledge for the given item.[25] Thus a patient with *semantic dementia* will be able to perform within the normal

[25] In their work on object recognition, Graham and colleagues have assessed the integrity of item-specific semantic knowledge by means of both picture naming and word-picture matching. For the work on face recognition, however, Simons and colleagues have only relied on picture identification (either name or provide some information about this face). Some corroboration across other semantic tasks would be welcome for assessing the patients' knowledge of people, since relying only on successful picture identification will tend to underestimate the set of items for which the patient has knowledge (since the

range on recognition memory tasks when the test image is perceptually identical to the image at learning, regardless of the state of their semantic knowledge (with the implication that semantic knowledge is not critical here rather visual memory). When the test image is perceptually different from that at learning, however, the state of the patient's semantic knowledge for that item is critical. If the patient retains knowledge of the given item then they will perform well on recognition memory for perceptually different images whereas they will perform poorly for the item if their semantic knowledge for the given item has deteriorated.

Thus this work demonstrates the importance of semantic knowledge for processing of both objects, and more importantly faces across differing images. It highlights that recognising different images of a given person requires semantic knowledge about that person.[26] Thus would a perceptual familiarisation paradigm where at best some rudimentary semantic knowledge is assigned to each face (e.g. a name or some other attributes) necessarily result in the successful recognition of a person across novel images? Would a more developed semantic representation aid novel image recognition? These are open questions.

1.4.3 General Conclusions from the Empirical Evidence

Thus there are clear differences in the way familiar and unfamiliar individuals are processed by the cognitive system. Familiarisation, moreover, is the critical process responsible for the transformation of some individuals to the familiar group. What happens during this process? From the review of the scant research available it seems there is not much data on this topic, especially on semantic familiarisation, with which to constrain any future models of person familiarisation. Yet this process is fundamental to person recognition – devising a model of *familiar* person recognition presupposes a process of *familiarisation.* Obtaining data on familiarisation then is one of the main aims of the current thesis.

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patient has to *generate* knowledge to the picture each time whereas in a matching task this is not the case). That said, however, the only influence on their results would be to make the difference between the known and unknown conditions larger which is not critical since the difference is significant anyway.

[26] Indeed one is tempted to think that perhaps a categorisation process is at work for successful recognition of the perceptually different items.

1.4.4 Some Attempts to Explain Aspects of Familiarisation

I will now review several attempts to explain aspects of familiarisation. I note that these models, of course, make assumptions in each area outlined in section 1.2.3.

1.4.4.1 Bruce & Young's pictorial and structural codes

Bruce and Young (1986) made an attempt to account for the difference in the processing of familiar and unfamiliar faces by positing differential use of the codes underlying performance on each type of face. Performance on unfamiliar faces is image-specific due to the fact that it relies heavily on *pictorial* codes. These codes are specific to one instance of viewing a face (e.g. viewing a picture). Performance on familiar faces, in contrast, is, normally, more dependent on *structural* codes. The latter types of code capture " [...] those aspects of a face essential to distinguish it from other faces". These codes can be used to explain the recognition memory data of Bruce (1982).

The main problem with this type of explanation, however, is that it just simply states that codes are formed when viewing a face without really specifying *how* that occurs. This contrasts with an implemented model, such as that of McClelland and Chappell (1998), which can explain the transformations in a quasi-real time manner. Bruce and Young's explanation of familiarisation, moreover, would consist in relating it to the differing stages of development of the structural codes for a given face. This again, while not incorrect, does not specify in detail what is actually occurring. Thus while the views of these authors on familiar / unfamiliar face processing do not seem incorrect in principle they do not explain how the codes are *generated* at a sufficient level of detail.

Unfamiliar and familiar faces also different in terms of semantic codes applicable on this model: only visually derived semantic codes are available for unfamiliar faces whereas both the former and identity specific semantic codes are available for many familiar faces. Visually-derived semantic codes are what underlies the ability to assign gender or age to a face, or indeed attributions of honesty, kindness etc. These codes are based on the physical characteristics of the face and people can assign these qualities to almost any face. In contrast, as the name suggests, identity-specific semantic codes are tied to a specific face and they include biographical details such as a person's occupation. In short, they *"specify who a person really is"* (Bruce, Burton & Craw, 1992, p121). Again this distinction seems valid and seems to capture a central difference between familiar and unfamiliar people but it does not explain how these codes are formed and maintained in any detail.

1.4.4.2 Burton's (1994) model of face learning (IACL)

Burton (1994) presented a modification to the original IAC model which sought to demonstrate new face learning. To consider this development we must briefly review the front-end to the original IAC model (Burton et al., 1990). The IAC model's front-end consists of pools of features (e.g. one pool for each critical dimension of face representation) and further one unit from each of these pools connects with the corresponding unit in the FRU pool with a unidirectional link. Thus input to the set of feature units which correspond to one FRU will cause that FRU to *fire*. Now, in the case of new face learning, as Burton notes, one has to consider how a given set of feature units comes to code for a specific new face. This is simply assumed by the original IAC model (Burton, 1994).

The IACL model (IAC with Learning) assumes only feature pools and a pool of FRUs. All units in the feature pools are connected to every FRU. Some FRUs are known at this point and these units have an excitatory link from the relevant unit in each feature pool along with inhibitory links from all the other units within each feature pool. Now the model is stimulated with activation of a set of units across the feature pools. If the set represents a known FRU then this unit will *fire*. If the set does not represent a known FRU then one unused FRU will still rise higher in activation than the other unused FRUs (given random variation in the strength of the links from each feature unit to each unused FRU). The links between this FRU and the set of feature units which caused its activation are then strengthened with a Hebbian update mechanism. With repeated presentation of the initially unfamiliar face, or equivalently activation of the same set of feature units, the links between the set of feature units and the FRU will become stronger, due to the Hebbian update mechanism. Thus a previously unused FRU comes to code for an initially unfamiliar face. With repeated presentation the FRU comes to code for a *familiar* face. The links between the given set of feature units and the FRU become strongly excitatory while the others become strongly inhibitory. This, in a nutshell, is new face learning in the IACL model.

Thus this simple demonstration of the possibility of learning within the IAC model of person recognition is successful. The main issue with this model is that it only addresses new face learning and not new person learning. Burton (1994) acknowledges that in real life we generally learn about people in a multi-modal fashion. Thus a model of person familiarisation has to address new person learning (through faces, voices, names, and critically, semantic knowledge).

Burton's model does, nonetheless, show that learning in an IAC model is not unachievable in principle. Thus it is a worthwhile first step. Unfortunately there has been no further development of this model to account for the processes of person familiarisation. I will comment, after reviewing the model of McClelland and Chappell (1998), on the similarities between the two accounts.

1.4.4.3 McClelland & Chappell's *Differentiation* model

McClelland and Chappell (1998) presented a model of familiarisation, based on likelihood calculation, and applied it to single item recognition.[27] The model employs, as its central component, a mechanism of *differentiation*. In the model, items are represented by detectors (which are vectors of features). With only one presentation of some item the detector's representation for that item will be noisy (the detector's probabilistic estimate of each feature being present will be reasonably close to the generic initial value of 0.5). With experience, however, the detector's representation for that item will become well differentiated (and thus the probabilities will become more differentiated). The hypothesis of the authors is simply that familiarity with some item results in a better knowledge of those features which comprise the given item and those which do not, that is, familiarity results in differentiation. This improved knowledge leads to more accurate performance on recognition and identification tasks.

[27] This model can account for the results which led to the falsification of the global memory models (see McKoon & Ratcliff, 2000).

Since this model deals explicitly with familiarisation, which is the focus of the current thesis, it seems sensible to outline the mechanism in some more detail.[28] Suppose we input a face to this system with the following (much simplified) structure (S_I = 0, 0, 1, 1) where a one signifies that the relevant feature is present and a zero that the relevant feature is absent. A detector will form which estimates, in each position of the sequence, the probability of a given feature being *present*. The initial representation of a detector is generic: it would be something like (D_I = 0.5, 0.5, 0.5, 0.5). On presentation of the stimulus, however, the detector's representation will be altered (D_I = 0.4, 0.4, 0.6, 0.6). There is an assumption here that with a presentation the probability feature estimates of the detector are modified in units of 0.1. This is simply for the purposes of exposition here. In the real model some function would control this parameter. If the same initial stimulus (S_I = 0, 0, 1, 1) was then re-presented at test, the likelihood of that item being old is 0.13 (0.6*0.6*0.6*0.6). To see why consider that the computation here considers the probability of the detector's representation matching that of the input and thus for some positions, where the feature is present in the input, the detector's probability estimate of the feature being present *is* the probability used in this calculation, but if the feature is not present in the input then the detector's estimate is one minus whatever probability is present in the detector's representation (or equivalently the detector's probability estimate of the feature being absent). (This is due to the fact that the detector's probabilities represent the probability of a feature being *present*.) If we consider the match of a new item (S_N = 1, 1, 0, 1) to the detector's representation we get a likelihood of 0.04 (0.4*0.4*0.4*0.6). So one can clearly discriminate old from new items with one presentation.

With the second presentation of the initial input, however, the detector's representation is altered once more (D_I = 0.3, 0.3, 0.7, 0.7). The likelihood of the initial (old) item now matching the detector's estimates is 0.24 (0.7^4) whereas the likelihood of it now matching the new test item is 0.02. Thus with repeated presentation of some stimulus the detector's representation for that stimulus becomes more and more refined – it comes to be more accurate at both matching the old items and at rejecting new

[28] This example is modified from one given in the introduction of McClleland and Chappell's (1998) paper.

items. This is the fundamental basis of the *differentiation* model. Please note, however, that this is an extremely simplified example and that the actual model is much more complex (specifically the importance of having a constant source of noise in the computations which is *not* modified by learning is central to the model's success in explaining the phenomena of single item recognition; this is not captured in the example above, see McClelland and Chappell, 1998). But this example hopefully captures the gist.

I have shown, moreover, that this model can explain much of the differences, on accuracy, between the processing of familiar and unfamiliar faces. This model, furthermore, provides a mechanism for familiarisation itself. Thus it seems a promising model to explore with respect to perceptual familiarisation. I note, however, that this model has only been applied to single item recognition with little consideration given to associative relations, which means it cannot account, in its current form, for new learning of people.[29] There are also some unresolved issues in this model with respect to how the same detector is recruited on subsequent presentations (see McClelland & Chappell, 1998) and further how the detectors are formed in the first place. These are certainly important issues requiring to be addressed in the future.

It is also interesting to note the similarities between this model of familiarisation and Burton's (1994) model of new face learning. The two models seem to work, at some level, on similar principles. Both initially begin with noisy representations which are refined with subsequent experience. Thus Burton's model may also be able to account for the data on the familiar / unfamiliar processing differences for faces.[30] Further both models fail as complete models of person familiarisation since neither can integrate the relevant knowledge of a person across different domains (face, voice, name and semantic knowledge). They could, most likely, be adapted to model various

[29] The REM model of Shiffrin and Steyvers (1997), which works on similar principles to that of McClelland and Chappell's model, may hold more promise in this regard. Unfortunately the exposition of the model is very complicated.

[30] I think this would depend though on construction of a suitable analogue with the tasks employed. This may be harder for the IACL model since the IAC model usually takes the number of processing cycles to reach some level of activation as being monotonic with response latency. It does not directly model accuracy like the *differentiation* model does yet accuracy is quite important in familiarisation studies. The *differentiation* model, however, does not model response latency which is also important in new learning (see above).

other perceptual input domains but how they would cope with integration across these domains or with semantic knowledge itself is not at all clear at present. I will consider this matter again in the final chapter of the present work.

The IAC model, further, attempts to explain response latency results in general whereas the *differentiation* model attempts to explain accuracy with respect to familiarisation. Both dimensions of performance need to be accounted for, however. One way to account for some latency effects in the *differentiation* model would be to use a result from the face recognition literature. Briefly, a more differentiated representation would be more distinctive, generally, than a less differentiated representation. Valentine and Bruce (1986) have shown that distinctiveness correlates with faster response latencies on a familiarity decision task (cited in Burton et al., 1990). The authors' definition of distinctiveness, however, is with respect to a given set of different faces at one instant of time, but there may also be effects of distinctiveness with the same face at different times during familiarisation. Thus perhaps this is what drives the faster processing of items which are repeated often (but see Logan, 1988; 1990). How to model accuracy with the IACL is also something that should be pursued though I have no specific suggestions here.

In summary, to model familiarisation per se, the whole process and not just perceptual familiarisation or one aspect of it, we need a theory of familiarisation which includes the processes of semantic familiarisation and further integrates knowledge of a person across different domains. This theory should of course be contained within a general theory of the person recognition system and should furthermore account for both common dimensions of response. Bruce and Young's broad theoretical framework provides a general guide as to some of the pertinent differences between familiar and unfamiliar person processing but it does not specify much about familiarisation per se.

1.5 Arguments For the Importance of Familiarisation

The most fundamental argument in favour of including the processes of person familiarisation within a complete theory of person recognition is that learning about new people is such a common and pervasive feature of our daily experiences. Though I am aware of no studies addressing the human person capacity limit it seems, by any practical measure, to be limitless. Bruce (1983) comments that: "[..] most people can recognise the faces of many hundreds or even thousands of individuals encountered in their daily life or through the media." Certainly a person does not learn all the faces they are going to learn at once. Thus the system must consistently be learning new faces (persons) across the lifetime of any one individual. I would argue that this is a central element of person recognition.

Bruce and Young (1986) did attempt to explain some of the differences in the processing of familiar as opposed to unfamiliar faces in terms of different types of codes underlying processing but they did not attempt to explain familiarisation per se. The models of Burton and colleagues (e.g. 1990; 1999), furthermore, have always been offered as models of *familiar* person recognition and moreover as 'snapshot' views of familiar person recognition. These authors would, I presume, acknowledge the fundamental importance of person familiarisation to a complete theory of person recognition. The reason, most likely, that person familiarisation has not been addressed to date is that the authors of these models were following common scientific practice by beginning with a reasonably simple formulation of the problems of person recognition, with the intention being to develop their model further to accommodate person familiarisation in due course (cp. Burton, 1994).

I would argue, however, that it may have proven more fruitful (or equally so) to have begun by consideration of the processes of learning new people, since the mechanisms used in such learning may well be the same mechanisms (to a large extent) used by the system in processing known individuals (see Bowers & Kouider, 2003). Moreover, in "snapshot" type models, the assumption of no new learning is problematical for some phenomena. In delayed repetition priming (e.g. temporal offset of a day say between prime and target presentation), for instance, between the two presentations of the repeated item other items may well have been learned. Does this affect the system? The IAC model cannot address this possibility at present. The question has to do with the capacity of the person recognition system and this is an area that has not seen much research.

A different, though in my view critical, argument for the importance of including the processes of person familiarisation in a model of person recognition is that the ability to add new members to any recognition system is a fundamental evolutionary property of such a system. A recognition system would not be of much use if it could only learn a fixed number of members and then no more. Flexibility would seem to be a crucial property of recognition systems which reflects the general evolutionary importance of the ability of new learning.

From these arguments I think it is clear that familiarisation is a central process in person recognition and should be explained by any satisfactory model of person recognition. I now turn to outline the limitations of current models of person recognition.

1.6 Limitations of Current Models of Person Recognition

In this section I first sketch some local problems (i.e. those inherent to a model's structure) with current models of person recognition before considering the more important deficiencies with respect to scope. The first four of the following criticisms (in Local Problems) apply equally well to the models of both Burton et al. (e.g. 1990; 1999), Bredart et al. (1995), and the framework of Valentine et al. (1996). The criticism in the second section (Problems of Scope) apply to each of the three theories.

1.6.1.1 Local Problems

Current models of familiar person recognition suffer from several inherent problems. First, models such as IAC, due to its abstractionist nature, do not specify the relation between semantic knowledge about people (represented by the SIUs) and memories of one's experiences with people. Yet it is intuitively clear that we do possess experienced-based memories of people and thus they must be represented somewhere in the human memory system. Why then are these memories not considered a part of the familiar person recognition system? Can they not be used for the purposes of recognition? (A related question is how the SIUs shade into generic knowledge of semantics etc. I note that in the framework of Valentine et al., 1996, there is at least a pool for general semantics.)

Second, due once again to the abstractionist nature of the model, no mechanism is specified whereby semantic knowledge is created out of experienced-based memories though it is simply implicitly assumed (see Whittlesea, 1997). This is important to the IAC model even as a model of familiar person recognition since we do learn new semantic facts about familiar people. The IAC model thus has to assume at least two representational types of memory, namely semantic and instances, and a mechanism to create semantics from instances. How does abstraction work?

Third, the IAC model simply presupposes that associative priming is the result of the shared semantics between two related persons. This is an assumption that has not, to my knowledge, been tested. Such a test would, however, be reasonably easy to devise. Indeed recent work by McNeill, Burton, Jenkins and Smith (2003) has begun to investigate the role of the co-occurrence structure of the environment in determining associative priming effects. How many semantic features, for example, do Victoria and David Beckham really share? Yet these are the kinds of prime and target combination that one would expect to obtain the greatest magnitude of priming with.

Fourth, McNeill (2002) points to a fundamental difficulty with the semantic representations in the IAC model. Simply put, SIUs can *only* be accessed in the IAC model after previous PIN access and it is McNeill's contention that any prior direct activation of the semantic system is "swamped" by the PIN activation of the SIUs (that is by the act of person recognition). Thus there is no way in the IAC model, at present, to account for paradigms (such as semantic interference) where the semantic system is activated *prior* to person recognition. Yet we know that one could think of politician and have Tony Blair come to mind. Thus the IAC model needs to address the issue of direct access to the SIUs.

Fifth, the IAC model only accounts for one of the dependent measures commonly used in the literature, namely response latency. Response accuracy, however, is also an important response measure which requires to be modelled in any complete theory of person recognition (it is critical, for instance, in the modelling of the learning process). Both common dimensions of response need to be accounted for and some would further argue that on top of accounting for summary measures of performance the distributions on each dimension should also be predictable (see McKoon & Ratcliff, 2000).

Finally, there are some empirical effects which are not captured by current versions of the IAC model (as presented in Burton et al., 1999). The name problem, that is, how to explain the differential performance on names as opposed to other classes of person-specific knowledge, is unresolved at present (see Carson, Burton & Bruce, 2000; see also Valentine et al., 1996). Furthermore the Burton et al. model appears to suffer from the refuted prediction outlined by Bredart et al. (1995) which was reviewed earlier (in short, the prediction that the more semantic facts you know of some person the longer it will take to verify or recall any one of them). As outlined earlier, this prediction depends upon the assumption that semantic decisions are taken at the SIUs in the Burton et al. model. More recent work by McNeill & Burton (2002), however, suggests that semantic decisions require simultaneous PIN and SIU activation to be taken (see also Young et al., 1994 [cited in McNeill & Burton, 2002]). Thus to verify that David Beckham is British one would need simultaneous activation of both David Beckham's PIN plus the British SIU. Now it is known that a given PIN will rise faster the more SIUs that are associated with it (e.g. Burton et al., 1990). Thus, in a revised version of the original IAC model, there is a mechanism which could account for the fact that participants are quicker to verify any one semantic detail of a given person the more semantic details in general they know of the given person. This rests, fundamentally, on PIN activation. Without this PIN activation the authors suggest that no semantic decision can be taken.

Thus, in a revised version of the IAC model, which takes the locus of associative priming, on semantic decisions, to be the PINs, it may well be possible to account for the findings of Bredart et al. (1995) and furthermore, this may lead to different predictions from the original IAC model with respect to the apparent refuted prediction. It should be noted that the attaching of the associative priming locus on semantic decisions to the PINs was not some post-hoc manoeuvre performed solely to account for the Bredart et al. data. In contrast it was motivated by independent experiments comparing the patterns of associative priming observed for familiarity and semantic decisions which were taken as specifying the same locus of priming for each decision type (see McNeill & Burton, 2002). What is important now, however, is that the effects of simultaneous activation of a PIN and SIU are explored in detail. Specifically what is the result of the computational interaction between the finding that the more SIUs attached to any one PIN the slower any one SIU will be to reach threshold with the fact that, for a PIN, the more SIUs that are connected to it the faster will be its rise in activation. Preliminary evidence (McNeill & Burton, 2002) suggests that the PINs are the dominant force but this requires further exploration. Thus a revised version of the original IAC model is not immediately refuted as such by the finding of Bredart et al.

On the other hand, the Bredart et al. model and the framework of Valentine et al. (1996) suffer from not accounting for naming semantic facts about people satisfactorily and, identical to the original IAC model, from an inadequate explanation of the naming problem itself (see Carson et al., 2000). There is also a problem with Valentine et al. (1996) assuming that prior explanations of phenomena hold for their refined framework without fully implementing the framework. One cannot be sure what sorts of effects may arise simply from the cascade of activation flowing around such a large system. Thus the whole framework needs to implemented.

Thus there are a series of local problems with IAC type models of person recognition. Further, I think that several of these arise from the exclusion of learning from the system. These issues, however, while important in themselves are not as important as the following main criticism.

1.6.1.2 Problems of Scope

The most severe limitation of the current models of person recognition is the failure to account for the new learning of individuals.[31] While it is admirable to account for a "snapshot" of the healthy adult person recognition system (consisting of a fixed number of individuals), especially at a first pass, the goal is a theory of person

[31] See Bowers (2000) and Bowers & Kouider (2003) for similar points with respect to extant models of word identification.

recognition which explains *person familiarisation* and thus encompasses both the learning of new individuals *and* the performance of the mature person recognition system on both familiar and unfamiliar individuals. We want to explain, in reasonable detail, the transformations of an individual from being unfamiliar to becoming familiar and perhaps highly familiar. What are the changes in representation and processing during the subjective transformation of familiarity?

Burton (1994) did provide a mechanism by which new faces could be learned by the IAC system. This mechanism, however, was not extended to the learning of new people (e.g. names, voices or most importantly, semantic knowledge). Whether the learning mechanism could be so extended is an open question at present. Learning of new *people*, in any event, is clearly crucial for any theory attempting to account for *person* familiarisation to address.

Thus, in summary, current models of person recognition are not applicable to the processes of learning new people. What we seek, of course, is a new theory of person recognition which explains all that the current models do,[32] plus the new processes (and thus a theory with a higher explanatory content). To be able to construct such a theory, however, it would be helpful to have some evidence on the processes of perceptual and semantic familiarisation. We already possess some evidence that considers the processes of perceptual familiarisation but there is not much on semantic familiarisation per se. The central aim of this thesis is to provide such evidence on the processes of semantic familiarisation.

Thus current models of person recognition are uninformative with respect to the processes of *person* familiarisation, yet I have argued that this is an important area in person recognition. The experiments in this thesis begin to explore the processes of the semantic familiarisation of new people.

1.7 Aim and Outline of The Current Work

The main charge against existing models of person recognition is that they are severely deficient in scope. That is, they leave out the phenomena of familiarisation. I

[32] Which is a tall order indeed.

have tried to argue, however, that familiarisation is a central feature of the person recognition system and something that requires to be explained. The main aim of this thesis is to report a series of experiments concerned specifically with the processes of semantic familiarisation, or, equivalently, with the learning of person-specific knowledge about new people. The experiments reported here should constrain future models of full spectrum person recognition (i.e. models inclusive of person familiarisation). Indeed I offer some remarks toward such a full spectrum model in the final chapter of the present work.

The first experimental chapter (Chapter 2) of the current thesis explores a different form of representation of person-specific knowledge (a script-like representation) than that currently employed in IAC type models and evaluates its usefulness in explaining some aspects of semantic familiarisation. This work highlights the importance of the learning context for subsequent processing of new person-specific knowledge.

Becoming semantically familiarised to a given individual means developing a semantic knowledge representation for that person. What determines the structure of that representation? In chapter three, I contrast participants' performance on a set of famous items with that observed for a set of newly semantically familiarised items in an attempt to shed light on this issue. This chapter suggests the importance of the statistical structure of a perceiver's experiences in determining what is the focus of their representation of person-specific knowledge for any individual.

The third and final experimental chapter of the present work (Chapter 4) makes a first attempt at investigating the development of semantic representations in an on-line task utilising a quasi-naturalistic learning period. Participants view episodes of a previously unfamiliar soap opera over several days and are tested at regular intervals within the learning period on an associative priming task. This allows one, in principle, to infer the status of participants' perceptual and semantic representations over the course of learning. The main result is the rapid nature of the self-priming effect obtained for the newly learned items (notably Experiment 4B). The findings on perceptual familiarisation are explainable on current models of familiarisation. Further theoretical development will be required to explain the results on semantic familiarisation, however.

The final chapter of the current work summarises and evaluates the experiments reported in this thesis and highlights their implications for future research. I also offer some future experiments which should progress research in this area. Most importantly, however, I attempt some theoretical development which should prove useful for subsequent formal modelling of full-spectrum person recognition.

Chapter 2

On the Representation of New Person-Specific Knowledge

2.1 General Introduction

In this chapter I explore whether an alternative form of representation of person-specific knowledge (a script-like representation) may prove more fruitful than that currently employed in extant models of person recognition with respect to the learning of new person-specific knowledge (i.e. semantic familiarisation). I demonstrate, by means of a verification task (Experiment 2A), that participants are sensitive to non-mentioned critical occupations (in a test phase) which *may* well have been inferred whilst participants learned about initially unfamiliar people. A second experiment (Experiment 2B), utilising a recall task, demonstrated a strong, but non-significant, trend towards greater recall of the implied occupation after a similar learning period. Such sensitivity to context is a fundamental part of the healthy operation of the cognitive system (e.g. McNamara & Diwadkar, 1996). The ability of extant models of person recognition to deal with the main findings is evaluated and alternative explanatory models are also considered. In sum, the verification experiment reported here is consistent with a script-type approach to the representation of person-specific knowledge but does not uniquely corroborate it. Other, more parsimonious explanations are preferred. Reasons, furthermore, for the discrepancy between the verification and recall experiments are discussed.

2.2 Person-specific knowledge representation in person recognition

2.2.1 Limitations of the IAC model of person recognition

The IAC model (Burton et al., 1990; Burton et al., 1999) is detailed in chapter one of this thesis so I refer readers there for an overview of the model. Here I examine specifically the representation of generic person-specific knowledge employed by the model. Person-specific knowledge is represented as a collection of abstract units in the IAC model (Semantic Information Units; SIUs). These units appear to specify arbitrarily coded, encyclopaedic facts (e.g. "born in Grantham"; "politician", "Margaret Thatcher" etc). These SIUs are shared between different people. Thus if two people are both politicians then politician is only stored once in the SIU pool and both identities access the same SIU ("politician"). Thus the representation of generic knowledge is efficient.

This mode of representation, along with the other pools in the IAC model, accounts for a wide range of *semantic* effects in the person recognition literature (e.g. associative priming [Burton et al., 1990], semantic priming [Carson & Burton, 2001], self-priming [Calder & Young, 1986] and the interaction between associative priming and distinctiveness [Burton et al., 1990]). The most serious criticism of the semantic representations in the model at present, however, is that they do not account for the learning of new person-specific knowledge about new people (see also Young, Flude, Helawell, & Ellis, 1994: 407). This is for one of two reasons: either the model fundamentally *cannot* account for such processes or the model has simply not been developed in this manner as yet. I will not repeat the arguments that I gave in chapter one as to the importance of including learning in a theory of person recognition, but they apply here as well.

Further to this major gap in the IAC model there is one other issue that arises due to the chosen method of representation of generic person-specific knowledge. How does the IAC model cause the correct contextual knowledge to come to mind when one is entering a given situation? Presumably by some link to other generic knowledge but how this would work is left unexplained by the IAC model at present. We do not just wander round recognising familiar faces in daily life, we are involved in events which have goals; even if the goal is just the activity itself. The IAC model makes no links to the knowledge required for this type of activity. One advantage of the type of representation I examine is this chapter, that is a script-like representation, is that such links may be easier to establish (given the initial point of script-like representations).

Thus these criticisms of IAC's semantic representations, allied with the criticisms of the model in general in chapter one, suggest that pursuing an alternative theory of person recognition may well prove fruitful. In the experiments reported in the present chapter I focus specifically on a possible alternative mechanism of representing person-specific knowledge. In the discussion to the present chapter I evaluate several potential means of representing person-specific knowledge in a theory of person recognition.

2.2.2 A new (old?) way forward

2.2.2.1 Scripts, Schemas, Frames ...

Scripts are related to both frames (Minsky, 1975) and to schemas (Bartlett, 1932). All three are abstract knowledge structures which are thought to be necessary for one to understand events in the world. They bring to mind a portion of world knowledge which is relevant to current experience (and which is required in order to understand current experience). It has been suggested that scripts are merely a more specific form of knowledge structure than either frames or schemas (Abelson, 1981). Thus a schema can be defined as "*an active organisation of past reactions, or of past experiences, which must always be supposed to be operating in any well-adapted organic response*" (Bartlett, 1932: 201). It thus controls behaviour in normal circumstances (and thought as well; when one thinks about some theory one is doing so with the basics from one's previous knowledge of the area). In the same vein, a script is "*a structure that describes an appropriate sequence of events in a particular context. A script is made up of slots and requirements about what can fill those slots. The structure is an interconnected whole, and what is in one slot affects what can be in another... Thus a script is a predetermined, stereotyped sequence of actions that defines* *a well-known situation"* (Schank & Abelson, 1977: 41). A script is then, literally, an inter-constrained bundle of expectations.

Scripts were first conceived of as knowledge structures in the service of understanding language and regular real-world situations. A common example is that of the "restaurant script". The script would consist of Props, such as tables, chairs, menus etc. and Roles, such as customer, waiter etc. and Actions, such as ordering, eating, drinking etc. Thus scripts lead to expectations about what a situation will entail. They are activated by 'headers' and more than one can be active at any one time. Scripts are proposed to be generalised from specific experiences. This was the initial conception of scripts proposed by Schank and Abelson in 1977.

Schank (1982) altered his conception of a script and proposed a theory of human understanding which includes as a major component a theory of human memory, that of dynamic memory. In this newer theory Schank proposes two main types of memory structures, general and specific. The specific structures are script-like representations which are organised by the general memory structures. There is no longer a "visit the dentist" script in memory (or restaurant script); rather the information needed to understand the relevant event is computed at the time of encountering the experience, guided by the general memory structures. This is due to the fact that there are many aspects of a trip to the dentist which would be shared with many other activities (a trip to the doctors, or to the lawyers etc). Schank now argues that this type of information which is common to these multiple activities would not be stored at the specific level of a script but rather represented in general memory structures (scenes). Schank postulates the general memory structures in order for there to be dynamic learning in the memory system. This would not be possible with only (the original) script-type representations.

Script like structures are seen as being "embedded as standardizations of various general scenes" (Schank, 1982: 16). Scripts, critically, are organised by higher-level structures according to the goal to which they are focused (Schank, 1982). Scripts are now taken to be active memory structures which can be changed by experience; that is they are modifiable in light of expectation incongruent material. At the necessary time of processing a composite knowledge structure is created to understand some activity. Schank then proposes the need for some structure in memory to organise the other structures; he calls the organising structures memory organisation packets (MOPs). These are needed in order to tie together the multiple elements required from general structures in the correct order for understanding some specific experience.

The definition of a script now becomes "a sequence of actions that take place within a scene" (Schank, 1982: 86). A scene is here defined as a physical setting plus a goal which is attempted to be actualised within that setting. Thus scripts are a subset of a scene. They provide the specific information whereas scenes provide general information. Both are necessary for successful comprehension of some event. In the words of Schank, a script *colours* or *instantiates* a scene.

2.2.2.2 Evidence and Arguments for Scripts

Experimental support for scripts (e.g., Smith & Graesser, 1981; Nakamura, Graesser, Zimmerman & Riha, 1985; Lampinen, Faries, Neuschatz & Toglia, 2000) suggests that they do explain some features of human understanding. The paradigm most often used in experimental investigations of script-type representations entails presenting participants with an event (either to read or listen to) and then testing participants' memory for sub-events contained within that event. Thus a participant could be presented with a story about the event of going to the doctor, for instance. Well-grounded empirical facts for script-based understanding of events are that, in a subsequent test phase, non-occurring typical actions (e.g. checking your pulse) tend to be inferred[33] from the script (leading to a high rate of false positives for such typical actions on a subsequent recognition task) and further that recognition memory (in terms of d') is better for atypical actions (e.g. giving you a ECG) than for typical actions (e.g., Smith & Graesser, 1981; Nakamura et al., 1985). Now the first finding is due to the idea that, due to script structure, participants may infer that a typical action did occur even when it did not since the action is expected with a high probability. The second finding, in contrast, is conjectured to be due to the fact that atypical actions do not blend into the script in the same manner as typical actions do since they are unexpected.

[33] It is contentious whether one can actually conclude that an inference has been made in these types of studies or whether a minimalist explanation would suffice (e.g. McKoon & Ratcliff, 1992).

They stand out clearly and this leads to easier discrimination of such actions. An effect of centrality is also found, with central features in a script being more speedily verified as belonging to that script than others (see Abelson, 1981, for a summary of some of these main effects).

Funnell (2001), moreover, uses script theorising to account for the pattern of impairment seen in patients with *semantic dementia* and claims that scripts are a basic structure of semantic knowledge. Funnell notes that semantic dementia patients are able to use objects in the correct manner in their daily lives whereas examination of semantic knowledge for the same items shows it to be grossly impoverished. She notes several properties of impairment seen in semantic dementia that reveal properties which a script-type representation is postulated to possess: first, scripts are goal based and patients with semantic dementia show better performance when a natural goal is present than when a goal is not present (e.g. Funnell, 1996, cited in Funnell, 2001). Funnell (2001) describes patient E.P.'s (Funnell, 1996) severely impoverished performance on matching a target object to a functional associate (e.g. matching a toothbrush to toothpaste in the presence of soap as a distractor), and further in either pointing to an object when the experimenter gestured its use or gesturing the correct use of an object itself (all six objects were typical of those which the patient used except the tin opener). In contrast, Funnell reports that when arranging the next appointment the patient went and obtained her calendar and ballpoint pen (she also used a needle correctly when asked to sew a button onto a shirt and further when asked to open a tin of cat food the patient went and retrieved her tin opener from the kitchen). The critical thing here is that these are similar objects, to a large extent, to those that the patient performs poorly with in the formal tests outlined above. The presence of a natural goal seems to aid her performance though this advantage is perhaps only present for personally familiar objects.

Second, physical scripts (a certain class of scripts which comprise a snapshot of the visual field) are extremely sensitive to physical context and with progression of the disease semantic dementia patients become ever more reliant on specific context. Funnell (2001) gives the example of a semantic dementia patient who could only use a jar of ointment for its purpose at home but not while staying in another location.

Further, patients with semantic dementia are better at recognising personally familiar objects than personally unfamiliar objects, and better when the object is in a familiar than unfamiliar location (Snowden et al. 1994, cited in Funnell, 2001). Both location and the specific object would be represented at the level of a specific physical script.

Third, script-type representations are taken to be the elements of a postulated dynamic memory system (Schank, 1982) and Funnell (2001) reports evidence of new learning in semantic dementia which she argues is consistent with the proposed operation of this system (for instance, that scripts are postulated to restructure on the basis of new experience and Funnell notes that semantic dementia patients' do learn but that their learning is limited to specific contexts).[34] Funnell ends by presenting a new model of semantic knowledge representation, based on scripts, which accounts for the above patterns observed in semantic dementia. The main point of her model is that semantic dementia patients lose the higher levels of this continuum model of semantic knowledge (e.g. concepts) while still possessing many specific event scripts on which to base performance (and also some general event scripts). Thus Funnell's work provides support for the idea that script-type representations may well be utilised by the human cognitive system (see also Grafman, Thomson et al., 1991; Allain, Le Gall, Etchary-Bouyx, Aubin & Emile, 1999).

Barsalou (1999), moreover, refers to *frames* in his perceptual symbol systems theory of knowledge. Frames are also large-scale knowledge structures (somewhat more generalised than a script). Nelson (1996: 17), moreover, argues that features of script-like representations are present in pre-school age children's representations of events (such as sequential structure, goal orientation and roles). Thus script-like theorising is still prevalent in mainstream cognitive science at present, across diverse fields (perception, language development and neuropsychology).

It seems then that some larger structure of knowledge is required to explain certain impairments seen in semantic dementia and, in addition, to provide the basis of a complete theory of knowledge (in adults and in development). Thus it does not appear

[34] Thus, semantic dementia patients are better at identifying a friend's name if the friend is someone they encounter in their present experiences than if the friend is someone from the past (Funnell, 2001, citing Snowden et al., 1994).

much of a leap to conjecture that we may represent person-specific knowledge in this manner. This is in contrast, as Funnell (2001) notes, to much work (including the IAC model) which views the structure of semantic knowledge as resulting from an encyclopaedic, abstracted structure (2001: 323).[35] This latter type of representation is successful when considering how participants or patients perform on tests of general knowledge (e.g. verification, naming and semantic priming). Such simple tasks, however, lack ecological validity.

The field of consciousness, at some instant, generally encompasses a wide range of stimuli of which attention magnifies a subset, but this subset is still invariably more complicated (a "stimulus complex", see Whittlesea, 1997) than that utilised in the previously mentioned semantic tasks. If we only use simple tasks (e.g. cat > dog priming), we are not going to necessarily be aware of the structure of knowledge required for successful interaction in the real world. Simple priming studies are useful as a simple starting point, but in the real world there are multiple elements of context which could be responsible for any priming effects in a given situation. In everyday life, one would assume, for any given situation which one enters, that one is cued by multiple contextual elements to access relevant portions of one's world knowledge (see Anderson, 1990). In text comprehension, for instance, to make sense of sentences one needs to access relevant world knowledge or else one will not understand the intention of meaning behind the sentence (see e.g. Sanford & Garrod, 1998, who argue for script-like knowledge structures). The point that I am making here is that knowledge representations in the human cognitive system have evolved to deal with the everyday life situation encountered by a person and thus not for the simple tasks which tend to be used in the lab. There is thus a danger in basing our models of human memory on simple priming tasks since they may greatly underestimate the complexity of knowledge representation present in the cognitive system.

Thus, in conclusion, there are powerful arguments for postulating a more structured representation of knowledge than that currently employed in many models,

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[35] The arguments is this paragraph are influenced largely by those of Funnell (2001: 323-324) and somewhat by Whittlesea (1997).

including the IAC model. Thus I examine, in this chapter, the utility of a script-type representation of person-specific knowledge in a learning paradigm.

2.2.2.3 An exposition of a person script

I now want to try and adapt the script idea to representing person-specific knowledge. The idea is that for each person we know there would be a script-type representation for them in memory. Thus one would possess *specific person* scripts which would record episodes of interaction with another individual in a given context (e.g. meeting a new person at work). (Below the level of *specific person* scripts would be *specific events* which would record what occurs in a given situation at a given time. Abstracted from such events would be the *specific person* scripts.) At a higher level of generalisation, there would be a *general person* script which results from the abstraction of the *specific person* scripts over, normally, differing experiences (abstracted over work and pub contexts perhaps for the new person). This is where the knowledge would still be tied to a given person. Generalised from these *general person* scripts (across many known individuals) would be a notion of what properties generally apply to human adults. By this I mean the general characteristics that apply to most people such as that people tend to have jobs (or have had jobs), that they tend to have families, that they tend to have attitudes to political matters and so on. Thus this would comprise a *generic person frame*.

The *general person* script for a person we know would comprise our person-specific knowledge about that person. Thus there would be slots for things like relation to you, occupation (or more likely, for what a person does, and further aspects of that), partner, where you usually see them, their name, and possibly their views on certain subjects. This script would be activated by the person's face, name or voice (all recorded in *specific person* scripts). The difference between *general person* scripts and *specific person* scripts is that the latter are constrained within one context (e.g. work context); the former collate information across contexts (e.g. across the work and pub contexts). Thus for a well-known person one would have several *specific person* scripts (from various contexts) and a single *general person* script which contains a kind of summary measure of these lower level contextually specific scripts.

The *generic person frame* would provide a template for new experiences to be mapped onto (when we meet new people there would be a generic template for what type or properties a person is likely to have). Thus one would have certain expectations about other people one meets, based on one's current knowledge of other people and certain situations. As certain elements of a new *specific person script* are filled this would lead to expectations about what values will fill the remaining slots (e.g. if I know that someone under the age of twenty spends much time at a University then there is a good chance that person is a student – but it is not necessarily so. The individual might be an electrician's apprentice working on a large contract). These expectations would lead to inference generation on the basis of incomplete knowledge.

2.2.3 Logic of the following experiments

If one's person-specific knowledge was structured like a script then one would expect predictable non-mentioned elements of some script to have been inferred, during learning, on the basis of partial, incomplete, knowledge. This is the main logic of the current series of experiments, and is clearly much related to inference production in general and the mechanisms by which it is achieved. I will consider these latter issues in the general discussion of the present chapter. In Experiment 2A participants first learn scenarios of information about previously unfamiliar people which imply certain occupations for these individuals. In a subsequent testing phase participants are tested on their processing of these non-mentioned occupations (using a verification task). If facilitation on processing of these implied occupations is observed then the conclusion would be that participants have become sensitive (somehow) to this implied information through the structure of the information provided in the scenario. Thus this would be consistent with a script-type representation where one would conjecture that the predictable occupation had been inferred. Experiment 2B uses the same methodology at learning while utilising a different task in the test phase (cued-recall) though the attempt is to demonstrate the same point: namely, sensitivity to the non-mentioned critical occupations.

Thus the rationale here is straightforward. There are reasons, outlined earlier, to look for an alternative means of representing person-specific knowledge than is present in current IAC type models. One alternative possibility would be a script-like representation. If a script like representation did underlie person-specific knowledge representation then we should expect to observe properties common to script representations (e.g. gap-filling or inference production) in a person learning context. I investigate this by having participants learn scenarios of information which imply a given occupation (alongside an initially unfamiliar face). The idea is that the predictable occupation should be inferred on a script-type representation leading to advantages on verification and recall for that occupation relative to an inconsistent occupation.

I note at the outset that this series of experiments do not uniquely corroborate the script-type approach to the exclusion of all other currently possible explanations. Nevertheless, the experiments reported in the chapter provide evidence which is relatively easily accommodated within a script-type theory in contrast to the extant models of person recognition. I will, in addition, examine the validity of additional models of human memory to account for the findings in the general discussion of this chapter (and as such examine which model offers the best prospect of implementing a hypothetical person script).

2.3 Experiment 2A – On the Verification of Implied Occupations

In the present experiment participants first learn scenarios of information about new people which implied certain occupations, dependent on gender, and are then tested on this information. The main interest is in whether we observe facilitation to the implied occupations or not in the test phase. The script-type theory would suggest that this would be the case.

The paradigm for the present set of experiments was adapted from that used by Macrae, Stangor & Milne (1994). These authors are social psychologists interested in studying stereotype activation and as such in their experiments they attempt to activate stereotypes indirectly and then investigate the processing of stereotypical consistent and inconsistent traits. This is similar to what I attempt here except I am concerned with how one learns new person-specific knowledge.

2.3.1 Method

Participants

Twenty undergraduates from the University of Glasgow were paid for their participation in this experiment. All were native speakers of British English.

Apparatus

Participants were individually tested on a Macintosh G4 Laptop using the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993).

Materials and Design

The experiment consisted of two phases. In the first phase participants learned previously unfamiliar faces with scenario information which implied a certain occupation and then performed a name verification task to assess their learning. Once perfect performance was attained in the name verification task, participants progressed to the second phase where they were tested on the critical occupations by means of a statement-verification task. The second phase followed on promptly from the end of the first. The main interest, in this experiment, is in the response latencies to the implied versus non-implied occupational statements in phase two, as indicators of possible occupational inferences made by participants.

Phase 1

Six scenarios of information were constructed to imply that the described individual performed a certain occupation.[36] The first and the last sentence of each

[36] For a full list of the six scenarios utilised in the present experiment see Appendix 2A. The experiments reported in this chapter are improved replications of earlier experiments in which there were some

scenario were neutral with respect to occupation: the first sentence always specified the individual's first name and where the individual lived (e.g. "Paul lives in Manchester.") whereas the final sentence specified either some detail of the individual's family (e.g. "Andrew is married with two children") or some hobby the individual had (e.g. "Anne likes reading mystery novels in her free time"). The second and third sentence of each scenario, in contrast, implied a certain occupation for each individual: thus a male face and the following two sentences would suggest a certain occupation, "He flies long hours most days. He has travelled all over the world with his job". This would suggest *pilot* whereas the same information with a female face and female pronouns would suggest *air-hostess*. Thus all scenarios could take on a female or a male form implying a different occupation in each instance. Changing the gender of a given scenario required simply the face image to be changed (from male to female or vice versa) and any gender specific words, mainly pronouns, to be changed.

I note here that the occupational implications generated by the learning scenarios are not all or none, but of degrees. I do not argue that one occupation is implied only: the argument is simply that one is implied *more strongly* than the other, and that this is dependent on which gender the scenario takes on.

Two versions of the experiment were created to ensure that across participants each scenario was seen with both a male and a female face. Six unfamiliar faces (3 male, 3 female) were randomly allocated to a scenario in version one. In the second version the same faces and scenarios are shown, as in version one, the exception being that the faces are shown with a different scenario. This enables, across participants, each scenario to take both the male and the female form. Specifically, the three male faces are randomly allocated to the three scenarios which had female faces in version one and vice versa for the female faces. Thus there were always three scenarios with male gender and three with female gender in each version.

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problematical items. These problematical items were replaced in the experiments reported here. I do not describe the earlier experiments due to brevity considerations.

Phase 2

After successful completion of the name verification task (see procedure) participants performed a statement-verification task where they were presented on each trial with a face from the learning phase and a statement below the face. They had to decide whether the statement could plausibly be true with respect to the face with which it appeared. One factor was manipulated, Consistency (Gender Consistent, Gender Inconsistent; repeated measure), which refers to whether the occupational statement is implied or not implied by the learning phase for the relevant face. Each of the six faces that were learned in phase one appears here with both a consistent and an inconsistent occupational statement. Thus, for the example of the male pilot from above, the relevant face would appear here with two statements: once with "John is a pilot" and once with "John is an air-steward". Note that, on the basis of the information given to participants in the learning phase, each of these possibilities *could* be plausibly true.

This structure is the same for each face from each scenario, thus giving 12 trials which should be responded to in a positive manner. Thus to create the task demands 12 filler trials were created where each of the faces from the scenarios appeared twice: each time with a different, obviously false statement (e.g. "John has a tail"). Two versions of this task were created in correspondence to the two versions of the learning phase.

Procedure

Phase One

On arrival in the laboratory participants were given a sheet of instructions informing them that they would be presented with a series of faces, each with some text, and that their task was to try to learn the faces and the information that went with each face. Participants were encouraged to try and meaningfully learn the faces and information by imagining the people as real-life people (and by deeply encoding the material). They were informed that they would be tested on this knowledge at a later stage. Participants were given one minute to study each face and scenario before moving on to the next one in the sequence. Once through the sequence of six scenarios thus took six minutes and comprised one block of training. Three blocks of training were initially administered. The order in which the scenarios were shown was randomised for each participant but constant for each participant across learning blocks.

Verification of Learning

After the initial study period participants' knowledge of the newly learned people was tested. Participants were presented with each face from the learning phase four times: twice with a correct name and twice with an incorrect name (incorrect names were the correct names for other faces from the learning phase).[37] There were thus 24 trials with each name appearing four times, twice with the correct face and twice with an incorrect face (a different incorrect face each time). The task was simply to decide whether there was a correct face-name match or not. Participants pressed the 'A' key to indicate "mismatch" and 'L' to indicate "match". It was stressed to participants that accuracy was central to this task (not speed). A criterion of 100% correct was required before progression to phase two. Any errors resulted in participants completing another block of training and then being re-tested (only three participants required greater than the standard three blocks of training which gives the mean number of training blocks required as 3.15).

Phase Two

Participants were seated comfortably approximately 50 cm from the LCD display. They were instructed to attend to the fixation cross and to make a Yes/No decision to each face and statement as to whether the statement could *plausibly* be true with respect to the above face. Participants were directed to press (on the keyboard) the

[37] See O'Donnell & Bruce (2001) for a similar verification task. I acknowledge helpful discussions with C. O'Donnell on devising an appropriate learning verification task. The point of having the same names (from the learning phase) appear on both "match" and "mismatch" trials is to force participants to utilise contextual memory, since if I had simply used a different set of names for the "mismatch" trials participants could base their responses in this task solely on familiarity.

'A' key for "No" and the 'L' key for "Yes". In this task participants were instructed to respond as quickly and as accurately as possible. A trial consisted of the presentation of a fixation cross for 250 ms which was followed by a face with a statement which remained on-screen until the participant responded. There was then a delay for 1000 ms before the next trial. Experimental trials were preceded by several practice trials to orient participants with the general task procedure.

2.3.2 Results

Participants took a mean of 3.15 blocks of training to successfully complete the name verification task in this experiment. Table 1 (below) shows the mean median response latency, for correct responses, to the Gender Consistent and Gender Inconsistent conditions of the statement-verification task. Medians were utilised for analysis in this experiment due to the fact that on several occasions there were extreme scores in certain conditions and these affected the means somewhat. Since medians do not suffer from this problem they were employed here. There seems to be quite a large difference in mean median response time between the two conditions with the Gender Consistent condition being responded to faster on average.

Table 1: Mean median response latency (R.L), one standard error (S.E.) and mean percentage correct (P.C.) to the conditions of interest in the statement-verification task of Experiment 2A.

Consistency	*Mean Median R.L.*	*1 S.E.*	*P.C.*
Gender Consistent	1392	96	97.5
Gender Inconsistent	1619	103	95.0

The response latency data were analysed by a related samples t-test which revealed a significant difference between the two conditions: t (19) = 3.07, p = 0.006. Thus responses to face-statement pairs were made significantly faster when the statement referred to a Gender Consistent as opposed to a Gender Inconsistent occupation. The same test on accuracy revealed a non-significant difference (p > 0.27), although the means suggest somewhat more accurate responding to the items in the Gender Consistent condition. Thus participants respond reliably faster, on average, to the consistent occupations, indicating an effect of previous exposure to the scenarios in the learning phase of the current experiment.

Investigation of Single-Item Performance

Ten out of the twelve items (six from each version) sit in the correct relationship of faster responding to the Gender Consistent statement than the Gender Inconsistent statement.[38] Furthermore (on accuracy) responses to items in the Gender Consistent condition are either more accurate or equally accurate to the Gender Inconsistent condition for ten out of the twelve individual items.

2.3.3 Discussion

In the present experiment participants' responses to Gender Consistent test statements were significantly faster than responses to Gender Inconsistent statements, as would be predicted from a script-type inference process. Participants are clearly sensitive to the structure of the information to which they are exposed during the learning phase of the current experiment. A script-type approach would assume that the implied occupation was inferred by the participant at learning.

2.4 Experiment 2B – On the Recall of Implied Occupations

Having shown that participants verify Gender Consistent statements faster than Gender Inconsistent statements (Experiment 2A) I now investigate whether participants are more likely to recall the non-mentioned Gender Consistent occupations in a similar task. If the plausible occupation is part of the mental representation of the respective individual, as a script-type model would predict, then one would expect this occupation to be recalled with a higher frequency than the less plausible occupation. The learning

[38] Appendix 2B contains a table of mean response latency and mean response accuracy for each individual face in both the gender consistent and the gender inconsistent conditions of each version.

phase of Experiment 2A is employed again in this experiment followed by a cued recall task. The primary interest here is in which occupations, if any, are recalled by participants in the recall phase of the experiment.

2.4.1 Method

Participants

Twenty undergraduates and postgraduates from the University of Glasgow were paid for their participation in this experiment. All were native speakers of British English.

Design and Procedure

The experiment consisted of two phases. In the first phase participants learned faces with scenario information and then performed a name verification task to assess their learning. Once perfect performance was attained in the name verification task participants progressed to the second phase where they performed a cued-recall task. The second phase followed on promptly from the end of the first. The first phase of the experiment, that is the learning phase of the experiment (including the verification of learning), was carried out in the same manner as that of Experiment 2A (faces were once more randomised to scenarios).[39] The main interest, in this experiment, is in the proportion of implied versus non-implied occupations recalled by participants in the cued-recall task.

Phase 2

Images of each face from the learning scenarios were here presented to participants, in a serial manner, as a cue for retrieval of information about the given

[39] There was one minor difference in the verification of learning task for Experiment 2B. Labels indicating which side of the keyboard each response key was located were present in Experiment 2A but absent here. As a result the learning procedure may have been more difficult and indeed participants did take longer, on average, to complete the training for this experiment. Importantly, however, there is no reason to expect this itself to lead to greater recall of one class of occupations relative to the other.

face. Images (Grey-scale, approximately 6 cm by 8 cm) were presented to participants on good-quality paper and participants wrote what they could recall about the given face on a sheet of lined A4 paper (using a different sheet for each face).

Participants were instructed that they would be presented with a series of cues to help them recall information about the people they had previously learned about. Participants were asked to *summarise* what they knew about each individual, while making it understandable to someone previously unfamiliar with that person.[40] They were specifically told that verbatim transcribing of the learning material was not the goal. In addition, participants were instructed that biographical details (such as whether person X was married or single, whether they had children or not, what person X does for a living/job, where they live etc) were the most important aspects to summarise (and also that visual characteristics were not of critical import). Participants were allowed one minute on each individual (there were six) though when time was called if the participant had begun a sentence they were told to finish it.

Table 2: Mean proportion of different types of occupation recalled in the test phase of Experiment 2B with selected standard errors in parentheses.

	Type of Occupation Recalled			
	Gender Consistent	Gender Inconsistent	Other*	Total
Mean Proportion Recalled	0.108 (0.035)	0.025 (0.018)	0.058	0.192

*** Other includes trials where both Gender Consistent and Inconsistent occupations were recalled (e.g. "may be either A or B") as well as trials where different occupations were recalled.**

2.4.2 Results

Participants took a mean of 3.5 blocks of training to successfully complete the name verification task in this experiment. The mean proportions of Gender Consistent

[40] Several pilot experiments with various instructions (e.g. 'Tell me everything you can recall about this person?", i.e. with no mention of the specific type of information to recall) did not show much recall of the occupations. Hence the instructions were altered to those used in the present experiment to try and encourage more recall.

and Gender Inconsistent occupations recalled by participants are given in Table 2 (previous page). We can see that only on a very small proportion of trials are any occupations whatsoever recalled (0.192). The difference, moreover, between the proportion of Gender Consistent (0.108) and Gender Inconsistent (0.025) occupations recalled is marginally non-significant: t (19) = 1.95, p = 0.066. Thus it seems that while it is unlikely for participants to recall any occupation at all, if they do recall an occupation then there is a strong trend towards it being the Gender Consistent one (indeed only 10 of the 20 participants recall any occupations whatever).

To investigate whether there was just a general problem in recalling information from the scenarios I considered participants' recall of the gist of the scenario information. For each participant and for each item, there was a maximum recall score of 5 (1 for Name, 1 for Location, 1 for hobby / family detail, and 1 for each of the occupational statements in the learning scenarios). Thus proportions were calculated for each item for each participant and then an average for each participant obtained (across items). In addition, fractional marks were awarded when only partial information was given. For a maximum score verbatim recall was not required, only recall of the *gist* (defined here as the main idea units). Correct recall of the gist from the learning phase is very good across the participants (Mean = .85) and thus the relatively small proportion of occupations recalled is not indicative of a general difficulty in recalling the learned information.

2.4.3 Discussion

There is a strong, but non-significant, trend towards participants recalling more Gender Consistent occupations than Gender Inconsistent occupations in the recall phase of the present experiment. Thus this is suggestive of what a script-type theory would predict. Unfortunately, however, this experiment has not revealed a significant effect of prior context on recall performance.

2.5 General Discussion

The first experiment in this series demonstrated that participants were significantly faster to verify the implied occupations after an initial learning period. Thus this experiment provides evidence for the strong effect of prior context on future processing performance. The second experiment, however, did not find such an effect when the same learning paradigm was utilised followed by a cued recall task (the relevant *p* value was 0.066). There was, nonetheless, a strong trend towards greater recall of the implied versus the non-implied occupation (1.95 standard errors of the relevant mean difference). Thus, on the whole, the results appear somewhat mixed. I find a large effect of prior context on Experiment 2A but not in Experiment 2B. I now consider why this may be the case before considering theoretical mechanisms which could underlie the present results.

2.5.1 Mixed Results

In both Experiments 2A and 2B participants are exposed to highly similar learning periods. Each experiment, however, utilises a very different task at test to probe the participants' knowledge. In the verification task (Experiment 2A), participants are provided with a presentation of the implied and non-implied occupations (on different trials) to assess the reasonable truth of such occupations for the relevant learned individual. In the recall task (Experiment 2B), on the other hand, participants are not presented with any occupations per se, rather only with a face cue on each trial. Thus participants have to generate the occupations for them to be present on the recall task. This is one important difference between the two experiments.

Perhaps it is the case, further, that a much stronger learning effect is needed to cause participants to explicitly generate an occupation whereas a weaker learning effect will suffice for the implied occupations to show an advantage in verification. I will now describe how this might work. It could be the case that verification threshold for the effect is lower, in some sense, than is recall threshold. Assume that the participant has inferred the implied occupation for some learned individual. When she comes to perform the verification trial for that occupation and that individual, the occupation will be activated strongly since it has been viewed in the external environment. On the recall task, however, there has been no external activation of the purported internal representation of the occupation. Thus it is harder to generate the implied occupation (no external activation) than to verify the occupation (external activation).

A second possibility for the different performance across the two experiments is the following. In the learning phase of each experiment, the scenarios will be learned and inferences may well be made by participants from such material to the implied occupations (at least on some trials). In the verification task a participant cannot block the effects of learning from influencing her responses. It is automatic in an important sense. In the recall task, in contrast, participants could be explicitly aware of the critical occupations while they are recalling information but choose not to recall the occupation itself for the following reason: they know that to do so is to stereotype the characters they have been learning about (indeed some participants commented that only with more learning did they become aware of the non-implied occupation being a valid possibility). Shortening the learning period should help investigate this issue further. The basic point here is that participants, in some sense, have more control over their responses in a recall task than in a verification task.

There is another problem, moreover, concerning the structure of the learning materials, which may contribute to the non-significant difference on the recall task. All of the learning scenarios were constructed in an analogous manner with no explicit mention of the critical occupation rather just leading statements implying a certain occupation. Thus when participants come to recall the information they may be explicitly aware that no occupation has been mentioned for anyone in the learning phase, explicitly, and thus to attribute one and only one would not fit with this learning regime. This is in spite of the fact that participants are told to summarise their knowledge of the participants and that in the information they recall should be some about what the person does for a living (or a job). I think it is a salient fact about the learning materials that no occupations are ever explicitly mentioned. I think, further, that all participants would be aware of this fact (since to be so they must only capture the gist of the structure of the learning scenarios over many repetitions of that structure). An obvious way to address this would be to alter the learning regime to have some scenarios be presented with leading statements while others (fillers) would be presented with normal occupational labels. This should make it much harder for participants to follow the above procedure.

Finally, it could be the case that no occupations are inferred by participants at all during the learning phase and thus the effects seen in the verification task (Experiment 2A) are just due to the effects of learning test congruency (I will elaborate this in later sections). Such effects of congruency may not be strong enough to influence performance on a recall task where participants have to explicitly generate non-mentioned occupations to a cue. Or, at a minimum such effects may have less influence on a recall task than on a recognition task.

Thus I have outlined several possible reasons why no significant effect shows through on the recall task while ones does show through on verification. There is, nonetheless, a strong trend in the correct direction. With following some of the suggestions outlined I think it might be possible to conclusively demonstrate an effect on recall comparable to that seen on verification. I now turn to focus on the most important finding from this chapter. That is, the demonstration of the effects of prior learning context on subsequent verification of the implied occupations. What theoretical mechanisms can account for such an effect?

2.5.2 On Demonstrating An Inference

An important point to note, which applies, in principle at least, to both experiments reported in the present chapter, is that we cannot claim that participants actually infer the predictable occupation in the learning phase (see McKoon & Ratcliff, 1992, on the difficulty of demonstrating that an inference has actually occurred). On a minimalist explanation all the participants do in Experiment 2A, for instance, is learn some predicting information and they are then faster to verify congruent as opposed to incongruent statements. There is no need, on this view, to claim that participants infer the predictable occupation. They may just recall the specific information given in the scenario at the time of test (the information associated with a given individual) and the difference in response latencies would then be due to the differing congruency of the statements with respect to what is already known. Similarly for Experiment 2B, the suggestion is that participants are more likely to generate a congruent occupation than an incongruent occupation. The current experiments do not allow us to differentiate between these two explanations (i.e. inference or congruency). Of course, the latter explanation just shifts the question to how congruency determines performance.

2.5.3 Use of the Ambiguous Scenario Paradigm

The specific paradigm used in the present experiments utilised ambiguous learning scenarios to investigate the matter of inference formation in new person learning. The ambiguity, however, was not perhaps critical for this purpose. For instance, the scenarios could have consisted merely of information which implied very strongly one occupation and not one of two possibilities. There are some difficulties with this revised approach, however.

Specifically, in terms of verification, what would be the comparison occupation? (What occupations would be compared, in terms of response latency, to the implied occupations?) What would the specific task be? The current design, furthermore, allows one to rule out the (relatively) uninteresting possibility that the facilitation observed on the verification task results solely from activation spreading from some concepts (e.g. hospital), present in the learning scenario, to related concepts (i.e. doctor) with greater magnitude than to other concepts (i.e. nurse) in that, across versions, each scenario is presented with both male and female gender (that is, on one occasion doctor is the implied occupation, on the other nurse). Four out of the six possible scenarios fully reverse, in terms of which occupation is facilitated, across differing genders (for instance, with male gender doctor is processed faster than nurse, with female gender the reverse is true). If the simple explanation above held, however, no such differences would be expected. The fundamental point is that a non-ambiguous scenario design would not allow this conclusion to be drawn. Since we can here conclude that the simple explanation is unlikely to hold we can specify that the effect is much more likely to be due to the whole context of the learning scenario (or at least a third order probe activating memory).

2.5.4 Mechanics of a Script-Type Explanation

How exactly does a script-type representation of person-specific knowledge account for the main finding here? As mentioned earlier in the introduction, a script-type representation would assume that knowledge about people (like knowledge about events) is represented in terms of expectation bundles. Thus a given adult person, at a given time, has a number of different script-like representations of people in their memory. They would have many *specific person* scripts, many *general person* scripts and a *generic person frame*. When this person comes to meet a new individual and learns only fragmentary pieces of knowledge about the new individual they have much knowledge of previous individuals to guide their inference processes. Thus when learning about a new person the *generic person frame* would provide the first base for processing. When information is learned about the person, however, a new *specific person* script would be created. When learning partial information, some of these slots would fill-up, and lead to expectations about what would fill the other slots. With respect to the present experiments, during the learning phase the *specific person* script would have slots filled by "male", "works at hospital" and "likes to keep patients well". This would, by way of an intermediary *person occupation* script (which stores occupations and features of occupations), constrain the individual's occupation slot to *doctor*. Thus the person infers that the newly learned individual has the specific occupation.

This is the essence of the whole script approach as I see it. One makes assumptions based on partial knowledge which can then be corrected in the light of future expectancy violations. Thus one could account for the result of Experiment 2A that participants respond faster to Gender Consistent statements than Gender Inconsistent statements about the unmentioned critical occupation. The further assumption is simply that if something is inferred then that would lead to faster response latencies for statements about the inferred entity than if it had not been so inferred.

In terms of the suggestive trend for participants being more likely to recall the non-mentioned Gender Consistent occupation (Experiment 2B) the script-type approach would assume the same processes occur as above. The further assumption here would simply be that, in this experimental context, entities which are inferred are more likely to be recalled than entities which are not so inferred.

Thus the script-type approach can account readily for the main result from the current series of experiments. This explanation, however, is only one of a whole spectrum and I turn now to examine some other strong potential candidates. I note that the script approach provided the motivation for the current series of experiments and successfully predicted (together with the work of Macrae et al., 1994a) the results of Experiment 2A (and the direction of the strong trend in Experiment 2B). There are certainly drawbacks of this approach, however, and I review these in a later section. One main issue is that this approach doesn't specify in much detail what is happening in the memory system with learning. There is simply a layer of assumptions about what happens during learning but no mechanistic account of the transformations thought to occur. This is a serious weakness of such an account.

2.5.5 An IAC Explanation?

Since the IAC model, in its latest incarnation (Burton et al., 1999), cannot account for the learning of new person-specific knowledge it will not be able to fully account for the results of the present experiments. The experiments reported here require a learning mechanism to be implemented in any model which will potentially explain them. Nonetheless, we can consider what the IAC model would predict to occur if we assume that some participant has learned the scenario type information about a given individual but knows no more (this, however, is a major concession to the IAC approach). We would have to postulate that the information from the learning scenarios becomes a series of SIUs (how, we do not know) – for instance we could have an SIU with content "works at the hospital" and another with "likes to keep his patients well", both linked to the same individual (these units seem to able to specify any fact related to a person).

How would an inference or congruency type explanation work in the IAC model? We would need to postulate that the two assumed SIUs are linked to other

SIUs, one of which would be *doctor* (through the PINs), and that in some way this link enabled one to subsequently process the linked occupation faster (and, possibly, generate it with a greater probability in a recall task). Consider processing the male face in the hospital scenario once the participant is familiar with the individual. His FRU would fire, followed by his PIN, this would then activate the SIUs which depict the occupational information from the learning scenarios and his gender. Activation would feedback, however, from these SIUs to the PINs of those people who share the same semantic information (e.g. works in a hospital, like to keep patients well, male). In turn some activation would pass back to the SIUs to which this set of PINs are linked to, one of which would presumably be doctor. Another would be nurse. The doctor SIU should be higher in activation due to there being more male doctors than nurses in the model. Thus, in principle, the IAC model may be able to explain the main effect here. It is unclear, however, whether the mechanism I have suggested would have any noticeable effect in a live simulation. There is a need for the idea to be tested.

In any case, an important point has been skipped here. Just how is the new individual and linked scenario information learned by the IAC model? Thus we are left asking for a fuller description of the IAC model's representation of semantic knowledge and of how new person learning might be implemented in such a model.

2.5.6 General Models of Memory

Several instance-based general theories of human memory, such as that of Hintzman (1986; 1988; now falsified, see McKoon & Ratcliff, 2000), Logan (1988), and Whittlesea (1997), could be utilised to account for the main finding here. As opposed to detailing the explanation for each model in turn I will do so for one theory from the class: namely, the theory of Whittlesea (1997). I note also that Anderson's rational analysis of human memory (e.g. 1990) would explain the current experiments in a highly similar manner.

In the learning phase these theories would posit that multiple traces were being laid down regarding the information present in the learning phase for any individual, covering multiple combinatorial arrangements of the learning material. The first explanation would assume that during the learning phase of each experiment, that is when participants are learning, for instance, that a male person is called Andrew, and that he flies long hours most days and has travelled much with his job, this stimulus compound forms a third order probe which activates / retrieves knowledge related to it. Thus more likely to be retrieved (or more highly activated) would be examples of this same information alongside other information (present in the same trace) which states that this person is a pilot. Thus this knowledge could be acquired and subsequently represented with the relevant scenario information during the learning period of the present experiments. Hence processing of the implied occupation in a verification task would be faster (and further recall of the implied occupation would occur with a higher probability than if it was not so activated).

In contrast, we could assume a minimalist explanation of the learning phase, assuming merely that the actual statements and the face of the relevant person have been represented in memory. How would the congruency of the presented occupation with the learned information lead to the implied versus non-implied difference?

Briefly, the face cue at test would activate the previous information from the relevant scenario. Meanwhile, the occupation presented on-screen would activate features of itself. Congruency could be computed as how well the presented occupation (in terms of its features) *fits* with the learned information in memory. To perform this computation, however, one would have to rely on pre-existing knowledge of what types of occupation are consistent with what types of information. Two possibilities emerge: either to activate knowledge of which occupations are likely given the third order probe of information from the learning phase or to fully activate the concept of the occupation which might include some information as to which gender is most likely (with the implied occupation being more likely than the non-implied occupation). Congruency in the latter case would be computed as the match between the memories generated by the presented occupation (what are the features of the occupation) with those of the learning information, whereas in the former case it would be computed as the match between information generated from the learning information (which occupations are most likely) with the presented information. Thus responses would be faster to the implied versus the non-implied occupations on both cases. On the first explanation the learning information is first activated by the face cue and then in turn activates a set of occupations (with the implied being more activated than the other). Congruency is then determined as the match between what occupations are activated at what levels against the occupation presented on the screen. The second case, however, is different in that the explanatory burden is on the presented occupation and not the information from the learning phase. This explanation, further, would not be able to easily account for any implied versus non-implied difference on a recall experiment (since there is no presented occupation on such a task) which limits its generality somewhat.

Thus in summary, both learning and test explanations of the main effect observed in the verification task are possible. Further there are two main variants of a test explanation in terms of congruency. Unfortunately the present experiments do not allow us to distinguish between these possibilities. I suggest, however, some critical experiments which may well be able to differentiate between the most important possibilities in the postscript to the present chapter. Furthermore, the general models of memory are consistent with each of the possible variants and thus do not allow us to choose between them.

2.5.7 Inferences in Person Recognition

Performing categorical inferences is essential to human cognition. Medin (1989: 1469) states that "Categorization involves treating two or more distinct entities as in some way equivalent in the service of accessing knowledge [..]". One has "to find points of contact between previous situations and the current context". This is reminiscent of Schank (1982) who states that we must understand the present in terms of our memories of the past. There is a cost benefit analysis, moreover, to be considered when discussing categorical inferences. There is a huge cost to treating each entity one experiences as being utterly unique and thus there is a benefit to treating some entities as similar in certain respects to those that have gone before (in terms of accessing knowledge). Inferences then, in general, are of paramount importance, and further all seem to involve going beyond the available information immediately present in a given situation.

In the social realm, psychologists have argued that stereotypical thinking is a cognitive tool. Macrae, Milne & Bodenhausen (1994b: 37), for instance, argue that, following Lippman (1922) the role of stereotypes is "to simplify perception, judgement and action" since "reality is too complex for any person to represent accurately". The main idea then is that "stereotypes function as energy-saving or resource preserving mental devices" (Macrae et. al., 1994b, p38, citing Allport, 1954; Lippman, 1922; Tajfel, 1969). Macrae et al. demonstrate in three studies, using dual task procedures, that this is indeed the case (see also Macrae et al. 1994a). Using stereotypes helps to reduce the capacity demands placed on the cognitive system by social interactions. Macrae et al. also note that people do not always think in a stereotypical manner; there are occasions when people do individuate but only when a number of criteria are met (it is rarer and takes more effort). Macrae, Bodenhausen, Milne, Thorn & Castelli (1997), furthermore, showed that stereotype activation is conditionally automatic; conditional on processing a person in a semantic manner.

Now in the current experiments we could view the learning phase as leading to the activation of certain occupational stereotypes of people. The faces (people) and information are processed, I would argue, in a semantic manner in the current experiments and thus meet the criteria for stereotypes to be activated. Further since it has been shown that stereotypes ease the burden of cognitive processing then it seems likely they will be utilised often. Thus it seems quite probable that the scenario information leads, in the learning phase of the current experiments, to the activation of occupational stereotypes of people. These stereotypes would clearly be differentiated by gender.

On this view, the predictable occupation would be inferred / activated by participants during the learning phase. Specifically, multiple-cue focused activation would spread in a network representing stereotypes and their associated traits (thus from the information given in the scenario to the implied occupation). This would lead one to expect faster response latencies to the implied occupation relative to the non-implied occupation and also to expect a greater probability of recall for the implied occupation (though this is not significant in Experiment 2B there is a strong trend). There are fatal problems with this explanation, however.

First of all, this explanation makes no reference to the perceptual and semantic learning which is presumably going on when a participant is learning about each initially unfamiliar person. This is critical and something I want to explain. Second, Macrae et al. (1994a) assume that activation spreads throughout a semantic network from a stereotype label to related concepts. The delay, however, between the prime phase and test phase in Macrae et al. (1994a) is on the order of minutes. Participants spend about five minutes listing the typical behaviour, appearance and lifestyle of either a *child abuser* or a *soccer hooligan.* They then progress to a word identification task or array searching task which both demonstrate more efficient processing of stereotypic traits. The problem here is that the validity of using a semantic network model to explain priming effects which occur on the order of minutes and not milliseconds is unclear. What Macrae et al. seem to have shown is a long-term advantage for the processing of stereotypical traits after a long period of stereotype activation. In person recognition, an analogous case would be if one presented Tony Blair for some judgement / task lasting five minutes and then presented Cherie Blair in a subsequent task and expected facilitation to processing of Cherie relative to a non-related person. While an interesting question, the point is that this would require a long-lasting facilitatory priming effect. Interestingly, Becker, Moscovitch, Behrmann and Joordens (1997 have presented an attractor neural network which predicts long-term semantic priming effects (over a minimum interval of two minutes) and the authors also report experimental data which demonstrates such effects. Thus a model of this type could plausibly account for the findings of Macrae and colleagues.

There are three ways in which a modified semantic network explanation could account for the main finding here. The first option would be if one supposed that at test, in response to the face probe the information from the scenario is retrieved and, at this time, activates related information in memory, hence the implied occupation is processed faster due to congruency. The second option would involve simply retrieving the information from the learning phase and then computing the congruency between that information and the detailed features of the presented occupation. The third option would be if the implied occupation were activated at learning and became part of the mental representation for the relevant individual. Thus in principle the same explanations possible for an instance based view are possible on the semantic network view. They seem to require more work on this view, however. Two options (1 & 3) necessitate specifying how multiple elements of the scenario conjunctively activate the relevant occupation. All options further require specification on how learning occurs in the semantic network (that is, associating the face with the scenario information) and options one and two require specification on how congruency is computed within a semantic network model. Some of these requirements (learning and possibly congruency) seem more difficult on a semantic network view than on an instance view.

Thus, in sum, the stereotype semantic network explanation offered by Macrae et al. (1994a) is not directly applicable to the main result reported in the present chapter. A refined semantic network, however, could possibly account for the present results. A key problem, moreover, with the semantic network explanation is that it does not specify the perceptual and semantic learning mechanisms assumed to be involved in such an experiment in much detail to date. Nor does it specify retrieval processes in much detail. These criticisms can also be targeted on the script explanation, though perhaps to a lesser extent. Thus what is needed is really a general explanation in terms of stereotype / inference theory and a more specific explanation in terms of human memory theory (preferably instance theory).

2.5.8 Evaluation

In considering the explanation responsible for the main effect here, we need to distinguish several possible sources of activation / retrieval of non-mentioned knowledge (see McKoon & Ratcliff, 1992). For instance, when simply processing the statements presented in the learning phase of the current experiments, when encountering, for instance, the words "patient" and "hospital" (in the doctor / nurse scenario), the critical non-mentioned words will be activated here (that is doctor and nurse) as the critical words are associatively related to the words present in the scenario. Note, however, that this is the same for the Gender Consistent and the Gender Inconsistent version of each scenario since the information objectively presented is the same (in terms of these "priming" words).

Activation could spread at learning to the related non-mentioned occupations but this explanation, in itself, does not account for the difference between participants' performance on Gender Consistent versus Gender Inconsistent statements in the test phase. There is need for a more detailed explanation paying attention to the whole scenario of information (i.e. the gender neutral plus the gender relevant parts). And once we say that what is activated is constrained by multiple elements of the context we are really back to the general memory explanation which I have detailed earlier, though it has to be noted that this explanation could be implemented as either an instance-based model or a network model.

The explanations from the general models of human memory for the present set of experiments suggest that the effects seen could be due to either learning or test processes. In conjunction, however, with an assumption of Logan's (1988) theory of automatization, I would strongly conjecture that the implied occupations are indeed activated or retrieved at the time of learning in the current experiments. The assumption is that retrieval from memory is obligatory, given that some item is attended to (see also Logan, 2002). Logan cites Stroop and priming studies as evidence for this assumption. Now clearly the retrieval required in the current experiment is more complex than either of these, much simpler, effects. Yet if a participant attends to three cues and forms one conjunct then retrieval should occur (male, works in hospital, has patients etc should cause retrieval of doctor with a higher probability than nurse). Whether attention is directed to the three cues to form one conjunct would be largely determined, I think, by the type of task the participant is engaged in: for instance, I think it would be more likely in a semantic task than in a word letter task. Assuming for a moment that the critical occupation has been retrieved, we would next have to consider the probability of something that is retrieved, such as the critical occupation, being represented with the original information in memory. Once again, the likelihood of this would seem to be determined by the task of the participant (on Logan's assumptions it would depend on whether the retrieved piece of information was attended to; 1988, assumption number one) and again I think the task participants are engaged in the present experiments would make this likely (i.e. learning about new people). That the critical occupations are retrieved / inferred at learning, therefore, seems to me to be far the more reasonable explanation. It also suggests that if we prevent participants from forming a conjunctive cue at learning then we should be able to block the effect. (I would argue, moreover, that realistically it would be unlikely for just one occupation to be activated, rather I think it likely that a set of occupations will be activated / retrieved along a gradient of plausibility for the given scenario information. This would then necessitate attending to and hence representing all that is retrieved alongside the original information but with different amounts of *strength* depending on the item's position in the gradient of plausibility). This explanation could, of course, be modelled using either a semantic network or an instance based theory though an instance-based approach perhaps requires less work.

I note, however, that regardless of whether the implied occupations are indeed inferred at the time of learning or whether the effect occurs due to congruency during the test phase, the objective result is the same: faster processing of expectancy congruent information (and perhaps also greater probability of recall of such information). In either case, prior context biases future processing performance. The experiments reported in the present chapter do not decisively specify whether these effects are learning or test based in nature (though see the postscript, p39, for a possible experiment which may be able to do so).

I suggest that instance models of human memory explanation along with the general stereotype / inference ideas would seem to be the best candidate for explaining satisfactorily the results of the current experiments. The script-type explanation, on the other hand, has the advantage that it motivated the current series of experiments and led to the expectation which was corroborated in Experiment 2A. In considering mechanisms of human memory, however, the script approach is not as well specified as the instance models of human memory, which is certainly a drawback of that approach. Further the script approach seems to assume an inference has been made and I can't be sure of that on the present data. The other explanations do not.

Considerations of parsimony dictate that we should prefer a simpler model to one that is more complex. Thus by this standard alone we should prefer the instance-based approach over the generic script-type approach, in terms of specific mechanisms, since the latter has to assume much more, such as many different types of knowledge representation (e.g. specific and general scripts, and their interaction) and processes of unconscious abstraction (see Whittlesea, 1997). There is also a problem that both the script type explanation and the refined semantic network explanation suffer from which is that they require more development to explain perceptual and semantic learning, instance based models do not. An instance-based approach could conceivably account for both perceptual and semantic learning as it currently stands. Furthermore, multiple cue constrained retrieval (important for two of the three plausible explanations) is not too difficult to specify on an instance model but it may require more work on a semantic network model. I do acknowledge, however, that there is not much to choose between in terms of an instance-based explanation or a modified semantic network explanation here.

2.5.9 Conclusion

Macrae et al. (1994a:371, citing Fiske & Taylor, 1991 amongst others) asserts that people use "inferential shortcuts... to make sense of a dauntingly complex social world". Indeed, if one considers the issue of cognitive economy (e.g. Rosch, 1978) and the complexity of the social world (Macrae et al., 1994a), it would not be surprising to discover that the brain makes certain assumptions about people we encounter, instead of remaining open to all the possibilities (which would certainly slow processing). What has been done in the present chapter is to extend this type of thinking to the issue of how we learn about new people, when considering the matter from a cognitive viewpoint.

Now with respect to the matter at hand, that of how the cognitive system learns new people, the experiments in the present chapter have the following implications. First, participants' learning of new people is highly context dependent, and subject to the use of expectation-based processing (Experiment 2A, suggestive effect in Experiment 2B). Second, a script-type representation of person-specific knowledge can account for the facilitation of expectation congruent material. There are, however, more parsimonious explanations. A full explanation, moreover, will need to comprise elements of: A) a general explanation in terms of both the social interaction of humans with one another (social stereotypical thinking; why this is useful etc) and the role of inferences in general plus either B) script-type representations (the filling-in ideas), or C) specific mechanisms from models of human memory (e.g. instance-based models or semantic network models to specify what occurs on an experience by experience level). I have attempted to provide a tentative attempt at such a full explanation.

2.5.10 Methodological Issues and a Change of Course

I will now examine some obvious weaknesses of the method used in the present series of experiments. These issues all relate to the learning methodology utilised. Subsequent to these considerations I will suggest a critical experiment which may allow determination of whether the effect seen on verification is a learning or test effect.

A major limitation of the current methodology is that the information provided in the learning phase was relatively impoverished compared to that which one would find in daily life. Specifically, only a single static image of each face was shown along-side simple statements of information. Clearly we do not usually learn about other people in this manner and thus the method has poor ecological validity. In daily life, when learning about a new person one would tend to encounter different *images* of the initially unfamiliar person, be it different views of an individual within the one context and further one might often, on top of this, encounter them in different contexts. Moreover, one would likely encounter the person's face in motion, not as a static entity. The key element here is the variation present in the learning materials for each item to be learned. Thus, as mentioned in Chapter 1, some studies of familiarisation utilise clips of faces in motion but just repeat the same clips throughout the learning phase. While this procedure allows one to incorporate motion into the learning phase of a familiarisation experiment, which is surely a reasonable aim, the variation within those materials from learning trial to learning trial is non-existent. Exactly the same problem is present in the learning materials used in the present chapter.

Further to the above issues, which really address learning about a new person in terms of visual appearance, it is immediately clear that in our daily lives we generally learn about new people in a multimodal fashion. That is, we learn about new people from their voice as well as their visual appearance, simultaneously. This type of person learning is excluded from the learning methodology utilised in the present chapter. The same issues about the importance of variation in the learning materials for each item to be learned applies to each mode of sensory knowledge.

There is a separate issue with respect to how the semantic content is learned by the participants. Thus in the learning methodology used in the present chapter participants simply read statements which inform them of certain properties of the initially unfamiliar persons. Thus, how rich will that representation be as compared to one's representation for someone one is learning about through real-life interaction? Furthermore, when learning about someone new in normal life, we don't tend to just over-learn a simple set of semantic facts – which is what is done in the current experiments. There is an issue with variation as applied to semantic learning as well as perceptual learning. In addition, one would, in everyday life, normally extract much semantic structure implicitly from the structure contained in one's environment.

Finally, one would normally interact with someone whom one is meeting for the first time – or perhaps there would be a three-way interaction occurring (yourself, the new [to you] person, and a colleague). Interaction between oneself and a new person is most likely important to the person familiarisation process.

Thus I have outlined here several ways in which the learning materials used in the present chapter could be improved with respect to approximation to real life. A central concern for both perceptual and semantic learning is the variation present within a set of learning materials compared to the variation present in everyday life. In addition, in terms of semantic learning, how one obtains semantic information about a new person might also be important (i.e. is one just told a set of properties or does one deduce from how one sees another behaving). Furthermore, the social interaction between oneself and the person one is learning about is likely to be important. The stimuli used in the present experiments are somewhat problematical in these respects.

These simplifications were necessary, nonetheless, to realise the ideas driving the current experiments and similar simplifications apply to much other work in person recognition where learning of some nature is involved (e.g. Cohen, 1990; Carson, Burton & Bruce, 2000). This is not, however, the only way the approach the matter of new learning in person recognition.

An improved method in this respect, which will be utilised extensively in the remaining experimental chapters of the present thesis, involves using an initially unfamiliar soap opera as the set of learning materials. Specifically participants watch episodes, in order, of an Irish soap opera ("Fair City"). Participants thus become gradually familiarised with the characters of the soap opera and one can probe the development of their perceptual and knowledge-based representations of these characters at different time points of the familiarisation process. These materials were purchased as part of an E.S.R.C grant held by Vicki Bruce and Mike Burton ('Getting to Know You – How We Learn New Faces' – see Bruce and Burton, 2003). I exploit these materials for further use in the further experimental chapters of this thesis.

Now with respect to the set of considerations outlined earlier I will now briefly evaluate the soap opera. First, participants who view episodes of the soap opera will learn about a character's visual appearance across different views and contexts, and further the character will be in motion. In addition, participants will also learn, in tandem with a character's visual appearance, about the character's voice. Thus, in terms of perceptual learning, the soap opera materials approximate to a much better standard the variation present in normal life.

With respect to semantic learning the soap opera materials allow our participants to extract their own semantic structure for each character from the structure of the soap opera, without the intervention of an experimenter. There is no over-learning of a given set of properties and participants are free to deduce information on the basis of the structure of information in the soap opera. Thus with respect to both perceptual and semantic learning the soap opera learning materials are a much better approximation to real life learning about new people.

Finally, with using the soap opera as learning materials participants often learn about characters in relative simultaneity – that is, about several individuals at once, not about each serially. We often do this in everyday life. Further the characters interact with one another. In addition, participants do not learn about the characters on an equal footing – some characters feature more often, some less. This, of course, is a better approximation to real life.

Learning about new people using these materials, however, is not synonymous with how we learn about new people in daily life. One important aspect missing is that of direct interaction with the person we are learning about – present in many cases of new person learning in daily life (and surely what evolutionary pressures selected primarily for). This aspect of new person learning is most difficult to realise experimentally with any degree of validity. Another point is that new person learning via the soap opera does not allow for the one-on-one new person learning which we all do in everyday life.

None of these points, however, affects the conclusion that the soap opera materials are, on the whole, a much better approximation to real life person learning than materials such as those used in the present chapter. One also loses some degree of experimental control in using such materials but the gain in ecological validity seems to far surpass any such loss. Indeed one might argue that it is the loss of control enables some types of variation to be like that seen in real life (i.e. differential learning experience with different new people).

Thus in light of the above arguments I decided to move away from using the type of learning materials used in the present chapter and instead chose to employ the soap opera materials as the learning materials in the further experimental chapters of this thesis. In the following chapter I train a set of participants on these materials in order to explore the structure of their person-specific knowledge representations for the soap opera characters relative to the structure of person-specific knowledge present in another set of participants with respect to famous people. In the final experimental chapter I use these materials in an attempt to track the processes of semantic familiarisation in an on-line manner.

If one were, however, to continue using the paradigm utilised in the present chapter then one should, I think, be attempting the following sort of experiment. Briefly the idea is the following: the learning phase would be presented in an implicit manner (e.g. something like "Evaluate these person profiles for several traits"). Participants could be made to experience each face and scenario for one minute at a time on three separate occasions (i.e. the same as in the present experiments) but have to rate the person (i.e. the face and the information) each minute on a different set of character traits. This manipulation should ensure that any intentional learning is minimised. Following the learning phase, in an ostensibly unrelated test phase, participants would be presented with a lexical decision task; the objective being to investigate whether facilitation is observed for the Gender Consistent relative to the Gender Inconsistent non-mentioned occupational words. If facilitation were to be observed then this would be strong evidence that the effect reported in this chapter does not depend upon intentional learning. More critically, it would also establish whether the effect reported was learning or test-based in nature. Thus two important questions could be answered with such an experiment. This is where future work utilising the present methodology should be focused in spite of the limitations of the approach.

Chapter 3
The Structure of Person-Specific Knowledge

3.1 General Introduction

My concern in this chapter is with the structure of person-specific knowledge. That is, with what determines which types of person-specific knowledge are preferentially represented, if any, in a given representation for some individual. We measure preferential representation of a given type of person-specific knowledge by means of the advantages which accrue to performance for that type of person-specific knowledge in various tasks, such as increased probability of recall and faster speed of verification. This line of research begins from evidence (which I review below) which suggests that participants do not perform in a uniform manner with respect to processing different types of person-specific knowledge. I want to enquire into why this is so. General theories of memory immediately suggest some initial, plausible, determinants of preferential representation. Repetition, for instance, of some element would be expected to lead to an *improved* representation for that element relative to an element which is not repeated. I argue that an explanation in terms of differential levels of experience with different classes of person-specific knowledge is likely to be the main determinant of preferential representation.

3.2 Differentiation of person-specific knowledge

I now review evidence for the differentiation of person-specific knowledge. Is there any evidence that some types of person-specific knowledge have an intrinsic advantage for a given class of people? The interest in whether such differentiation exists stems from the prior theoretical interest of understanding the structure of person-specific knowledge representation. If the representation of person-specific knowledge is not uniform then some principles must determine why there is differentiation. These principles inform us of the determinants of the structure of such knowledge. Experiments on the recall of person-specific knowledge highlight what types of knowledge tend to be represented for a given class of individuals and, importantly, also show the relative probability / frequency of recall of each type whereas experiments on verification show which information is processed most speedily. Both sorts of evidence reflect the underlying representation and processing of person-specific knowledge. The latter is the prime concern here.

3.2.1 Experimental Evidence

Occupational information has been found to be at an advantage for famous people in terms of both frequency (and probability) of recall and speed of verification, relative to other types of person-specific knowledge. Yarmey (1973), for instance, in a Tip of the Tongue experiment, found that profession was the most frequently recalled piece of information when participants could not recall the name of the relevant famous face. Bredart et al. (1995), furthermore, presented 7 participants with 24 famous people (actors or TV presenters), either by a face or name probe, for recall of person-specific knowledge. Participants were given five minutes on each item. Occupational details once again came out as the most frequently recalled type of information (610) whereas the amount of family information recalled was substantially lower (210). Other types of information given included nationality (177), political opinions (10) and personality traits (19). Thus for famous people occupational information seems to be the most frequently recalled type of person-specific knowledge.

Johnson (1990), moreover, presented participants with famous faces and asked them to recall information of a biographical nature. He found that occupational responses were the most common (of his 20 items, 92% were given an occupational response, compared with 84% named, and 76% for which associates[41] were provided). Thus occupational information seems to be recalled with a higher probability than other types of information, for famous people. Thus on both frequency of recall and probability of recall, occupational information is at an advantage relative to other types of person specific knowledge, for famous people.

[41] These are not solely relational associates (e.g. names of partners etc).

Occupational information has also been shown to be processed more speedily than other types of person-specific knowledge. Young, McWeeny, Ellis and Hay (1986a; Experiments 3 & 4) showed that occupational categorisations (e.g. responding verbally "Yes" to a politician and "No" to a non-politician), of famous faces, were faster than naming of the same faces. Young, Ellis and Flude (1988; Experiment 1), moreover, showed in a same / different task, which involved either deciding whether two simultaneously presented faces had the same occupation or not, or whether they both had the same first name or not, that occupational decisions were made faster to famous faces than first name decisions (on both *same* and *different* decisions). In their Experiment 2 the authors demonstrated that the same pattern held when participants made separate decisions to each face (i.e. it is a politician or non-politician or is the person called David or Michael). Thus occupational information seems to be processed more speedily than names for famous people, at least when accessing that information from a face.

Johnston and Bruce (1990), furthermore, extended this previous work and compared the processing of occupational information about famous people with processing of nationality information, and status (is the person alive or dead) information about such people. The authors employed a same / different task in their Experiment 1 and participants either matched two simultaneously presented faces or surnames (between participants) on three separate tasks (occupations; nationality; status; task order was counterbalanced across participants). Johnston and Bruce report that for both faces and surnames correct *same* decisions were made faster on occupational criteria (singers or non-singers) than either nationality (British or American) or status criteria (alive or dead). Thus occupations do seem to be processed more speedily than other types of person-specific knowledge for famous people.

In summary, for famous people, occupational information is the most frequently recalled type of person-specific knowledge and the type which is recalled with the highest probability (Yarmey, 1973; Johnson, 1990; Bredart, Valentine, Calder & Gassi, 1995). Further, for this same class of people, decisions about occupational information are made faster than any other type of person-specific knowledge which has been tested (e.g. Young, Ellis & Flude, 1988; Johnson & Bruce, 1990).

Further to the above studies, many experiments have been carried out where the participant's task is to learn some person-specific knowledge, for instance a name and occupation, to each face of a set of unfamiliar faces (see e.g. Cohen, 1990; Carson, Burton & Bruce, 2000). Participants then later have to recall this knowledge at various intervals. This research regularly demonstrates that occupational information is the easiest type to successfully recall, notably easier than the recall of names (the 'name' controversy is beyond the scope of this chapter, see Carson et. al., 2000) or other types of knowledge (e.g. possessions). This has led to some researchers, e.g. Cohen (1990), claiming that occupational information is a central component in the representation of person-specific knowledge.

Thus converging evidence from free recall and verification tasks, utilising famous people, and from unfamiliar person learning tasks, demonstrates an advantage for occupational information relevant to the other information tested. In the first case, that of free recall about famous people, there is no doubt that occupational information is recalled with the highest probability and further that it is also the most frequent type of response. In the second case, that of speeded information processing tasks (e.g. matching, single item decision) utilising famous items, while there is a clear advantage for processing of occupational information as opposed to the other information tested, there is a problem in that only limited domains of person-specific knowledge have been tested (i.e. occupation, nationality, name and alive/dead). There are other classes of person-specific knowledge, however. Relational information, for instance, such as information about the target's partners and family, has not been directly compared with occupational information in a famous person verification task to date.[42] The importance of this class of information is suggested by thinking about what is central to knowledge representation for personally familiar people. Relational information seems intuitively more important for this class of people (e.g. think of your relatives, friends, partners etc). In addition, having a partner and a family, and friends, are important properties of human persons interacting in the world. Thus it *could* even be the case that relational information is processed faster for famous people than occupational. Thus the

[42] The phrase *relational information* is used in this chapter in a restricted sense to refer only to a given person's family / partner / friend relations. Thus work relations are explicitly excluded in this usage.

advantage here for occupational information may only be relative to the specific information types included in the verification task.

For the third case, that of unfamiliar people learning, once again only selective types of person-specific knowledge have been used (relational information was once more neglected). Again the occupational advantage here may just apply over the other specific information types tested (names and possessions). Thus *perhaps* relational information may be the most accurate information recalled in such a task. It transpires then that some of the evidence in favour of an occupational advantage for famous people and for learning of unfamiliar people has been obtained from experiments which have not tested the full range of person-specific knowledge. The relational class of information has been left out of experiments with both types of people. Yet this class of information is important (see the next section).

Thus, in summary, there is a clear occupational benefit for the recall of information about famous people (both in terms of probability of recall and frequency of recall). On matching and verification tasks an advantage for occupational information is also found on response latency (e.g. relative to nationality and name information). I test, later in the present chapter, the generality of this processing advantage by comparing speed of processing of occupational and relational information, for famous people, in a speeded verification task. On unfamiliar person learning tasks, moreover, an occupational advantage in terms of recall accuracy is shown (relative to names and possessions). It would be interesting to investigate whether this advantage generalises when relational information is included as a comparison class. Thus an occupational benefit emerges on both recall and on matching / verification tasks, for famous people, and further also on unfamiliar person learning tasks.

3.2.2 The Class of Relational Information

The importance of relational information as an additional category of information arises from consideration of the types of information which are important in terms of the representation of those individuals who are *personally familiar* to us (i.e.

those people with whom we directly interact). Intuitively the occupation of one's mother does not seem a pertinent basis for the representation of person-specific knowledge for that individual. Rather, the fact that she is one's mother would seem a much more likely basis. This latter type of information belongs to the class of relational information. This class is thus an important addition to the occupational class, especially when considering personally familiar individuals. The neglect of relational information in the studies reviewed serves as a reminder that one must be careful not to over generalise results obtained with famous people to the set of all people.

3.2.3 An Explanation of why Occupational Information should be Preferentially Represented for Famous People

For famous people, it does seem that there is a natural advantage for occupational information as opposed to other types of information. So what determines which information has an advantage, if any, in the representation of person-specific knowledge? Perhaps the information that has an advantage would be that acquired from *how you know the person* (i.e. the role that you know the given person from). Thus occupational information is predominant for famous people since we know famous people mainly through their occupations. Thus we would predict for a personally familiar individual, who we know through their occupation (such as a shopkeeper), that occupation would be the focus of the representation of person-specific knowledge for that individual. For family members (and partners), in contrast, this view would predict that occupation would typically not be the main determinant in the representation of person-specific knowledge; rather relational information would be so.

A more realistic view, of course, is probably that, if we know a person well, we probably know them in several different roles. Thus I can think of my mother, whom I know primarily in that role, but also as a doctor, as a wife to my father etc. Most likely, at least for well-known personally familiar people, our representation of knowledge for that individual will comprise multiple roles. Or perhaps there is a composite role containing aspects of each specific role. The question then becomes, however, which of these roles or aspects is dominant for any individual. The point would be that I would expect occupational roles to be dominant for famous people but relational roles to be dominant for many types of personally familiar people.

Thus the essential aspect of this account is that one's representation of person-specific knowledge for any given person will be focused on the type of information which determines the role you predominantly know the person from. This is the type of information which will show a performance benefit.

Given the above, I would predict that occupational information should be at an advantage relative to other types of person-specific knowledge for famous people since this is how we predominantly know this class of people. Thus, in both recall and verification tasks, occupational information should be facilitated in tasks using famous items. In the present chapter I directly compare the processing of relational and occupational information for two different classes of people, namely famous people and characters from a soap opera, in order to investigate the determinants of preferential representation in the representation of person-specific knowledge. Is it the case, as some have suggested (e.g. Cohen, 1990), that occupational information is preferentially represented for all people? Or is it the case, as I have suggested, that experience determines preferential representation? The experiments reported in this chapter seek to demonstrate that the latter position is correct.

3.3 Experiment 3A – Probability of Recall of Occupational and Relational Information for Famous People

In the following experiment I investigate participants' probability of recall of different types of information for a set of famous people. Participants are probed for recall by face, name and semantic cues. I use the different cues simply for the purpose of examining the extended generality of the results: that is, to investigate whether there are any differences in probability of recall as a function of the probe type. I have no a priori reason to expect different patterns of information recall across the different cues with respect to the main question (i.e. the relative probability of recall of different types of person-specific knowledge) unless performance in the semantic probe condition is influenced by participants not generating the semantic information which is part of the probe itself (thus, for instance, if the semantic probes tend to be occupational in nature we might expect less occupational information to be recalled in this condition, relative to the face probe or name probe conditions). Based on previous research I would expect occupational information to have the highest probability of recall. Given that this information is, presumably, encountered most frequently alongside famous people this would provide initial support to the ideas sketched above. I note at the outset that in both this experiment and Experiment 3B my interest is in the relative probability of occupational and relational information recalled by participants.

3.3.1 Method

Participants

Eighteen undergraduate and postgraduate students from the University of Stirling and the University of Glasgow were paid for their participation in this experiment.

Design & Materials

The main interest in this experiment is in the relative probability of recall of occupational and relational information to famous person cues. One factor was manipulated in the present experiment, Probe Type (Face, Name or Semantic; repeated measure).

Stimuli

A total of 24 famous people were selected for use in the current experiment. For each of the 24 famous people selected, firstly an image of their face was printed out on photo-quality paper. Secondly, their full name was printed out on a piece of A4 paper centred in bold Times font (Pt. size 48). Finally, the experimenter created a semantic detail for each famous person. The constraint on the semantic detail was that it had to uniquely identify the famous person and not be confusable with any other famous person (e.g. "The person who is the current President of the USA", see Appendix 3A for a full list). The semantic detail was printed out on A4 paper in Times font (Pt. size 48). Thus for each famous person three probes were created, a face image, a full-name and a semantic detail. This gives 72 probes overall, 24 of each kind.

Recall Task - Design

Participants were presented with eight probes of each type. Initially the famous people were randomly assigned to one of the three cue conditions and this created version one of the experiment. Two further versions of the experiment were created by rotating the items round so that the eight items that were cued with a face in version one were cued with a name in version two and with a semantic detail in version three. This ensured that across participants each famous person would be probed by each of the different cues.

Procedure

Participants were instructed that they would be presented with a series of cues to help them recall information about famous people. (The cues were presented to each participant in a folder in a random order.) Participants were instructed to recall information about each cued individual. Participants were allowed a maximum of one minute to recall information for one character before moving on to the next one. After recalling information for a certain character, participants were asked to make a saliency judgement to each piece of information recalled for each character (this data is not reported in the present thesis). The experimenter recorded (hand-wrote) the information recalled by the participant to each cue.[43]

[43] I note that the method of recording recall in this experiment is not as optimal as it could have been. For instance, as opposed to having the experimenter record the information we could have had the participant simply write their own responses (this would have avoided relying on the short-term memory capacity of the experimenter, since the recall period was time constrained). Thus due to the particular method employed here for recording participants' recall, we cannot say with certainty that all the information that

Table 3: Mean probability of correct name recall, miss and miss-attribution for each probe type for Experiment 3A with one standard error in parentheses.[44]

Probe Type	*Named*	*Miss*	*Missattribution*
Face	**0.72** (.057)	**0.20** (.059)	**0.028** (.013)
Name	NA	**0.014** (.010)	**0.007** (.007)
Semantic	**0.76** (.046)	**0.12** (.036)	**0.014** (.010)
Mean	**0.74** (.040)	**0.11** (.027)	**0.016** (.007)

3.3.2 Results[45]

The central interest in the present experiment is in the mean probability of recall for different types of information to the set of famous item cues. Prior to reporting on this measure I first consider some generic measures of performance. For each item that a participant is cued with they can make one of two main errors. A participant can *miss* an item, which I define as providing no response to an item ("I don't know who it is" etc). A participant, moreover, can also misidentify a given item as being another person. I call this latter error a *misattribution.* Table 3, above, shows the mean probability of participants making a miss, a misidentification and, in addition, of correct name recall (the latter defined as the correct recall of the target's whole name). One further type of error, not included in the categories mentioned above, is that of an *indeterminate response*. This occurs either when participants say multiple names in

was recalled by participants was successfully recorded, though the majority of it was. Importantly, there is no reason to expect anything but a random distribution of errors in recording recall across the different categories of response. Further we should note that the method produced results comparable to that found by previous research (e.g. Johnson, 1990).

44 Note that the proportions in this table for each probe type summed across Named, Miss and Misattribution do not equal one. This is due to the fact that there are items for which participants do not correctly name the item yet do recall correct knowledge to the item (that is, they do not make a miss or a misattribution).

45 For one semantic cue, that for Lennox Lewis, the events relevant to the cue changed during the running of this experiment. The cue was "the person who is world heavyweight boxing champion of the world" and while the experiment was being run, Lennox Lewis lost his title (April 2000). Thus the semantic cue was altered to "the British sports-person who was recently world heavyweight boxing champion". Responses to this semantic probe were excluded from the analyses which follow due to this disparity and the fact that several participants were given an incorrect cue. This resulted in a loss of potentially six data points from the analysis.

response to the target cue or just say one name but are sufficiently unsure of whether it is correct so as not to recall anything more. This occurred on only three occasions and hence has a very small probability of occurring (about seven instances per thousand trials).

A one way ANOVA on the probability of miss data with one factor, Probe Type (Face, Name or Semantic; repeated measure), revealed a significant effect of Probe Type, $F(2, 17) = 6.44, p = .0042$. Tukey HSD post hoc tests showed that the only significant difference was that between the face and name probes ($p < .01$; $\overline{X}_F = 0.201$; $\overline{X}_N = 0.014$; $\overline{X}_S = 0.12$). Participants thus made misses with higher probability to face probes than name probes but there was no difference between the probability of miss with a face or name probe and a semantic probe. The same ANOVA model applied to the misattribution data revealed no differences in the probability of a misattribution across the different probe types ($p > 0.2$). Finally, a one-way ANOVA with the following factor, Probe Type (Face or Semantic; repeated measure), was applied to the probability of correct name recall data. This revealed no significant effect of Probe Type ($p > 0.5$). Thus participants were just as likely to correctly name a target from either a face or a semantic probe.

Thus, in summary, the different probe types do not differ significantly in terms of either likelihood of correct name response or likelihood of misattribution, but only in terms of likelihood of a miss. The fact that faces were missed a greater proportion of the time than names warrants some comment. I would argue that this is likely to reflect factors such as the relative ease of identification across the two types of probe. There would seem to be less confusability with a name than with a face, for example.

3.3.2.1 Classification of Information

The occupational and relational categories were chosen as the main categories of analysis here for the reasons outlined in the introduction. For each participant's response set to each item, a correct relational response and a correct occupational response were searched for. This necessitates deciding, beforehand, on what is acceptable as a relational and occupational statement. The occupational category refers to information pertaining to the occupations of the famous people. The relational category, on the other hand, refers to information pertaining to the relational details of the famous people – specifically the family, partner and friend relations.

Thus a simple response in each response category here would be statements like: "Prime Minister", "actor", and "married to Posh Spice", "has many kids", respectively. I include film and song titles in the occupational category so that a response such as "was in X" or just "X", where X is some film, is scored as a correct occupational response if the given target was in the relevant film (e.g. "in Braveheart" for Mel Gibson). In an analogous manner, for politicians I score responses such as "was in charge during Falkland's war", "Northern Ireland peace process – got publicly involved", and statements such as "not sticking to pollution charter – not participating in it anymore" as being correct occupational if indeed the statement is correct. Thus the correct occupational response does not necessarily have to be the generic one (e.g. singer, actor etc) but just something which is strongly part of the target's occupation.

There are also more complex statements such as the following: "had troubled presidency". This statement has a subjective element to it for which it is often difficult to determine correctness. From the original statement, however, one can derive the simple statement that the target had a presidency and evaluate that statement for correctness. This is the approach followed here. Thus whenever such a complex statement, for which it was difficult to determine correctness, could be *reduced* to a simpler statement that was the approach taken.

In addition to the above types of statement there are also *partially correct* statements. Some examples would be "wife Ann and 2 kids', "married to Gwyneth Palthrow". These examples are partially correct – for the first example the target's wife is called Anne but he has three children not two. For the second case the target is married but not to the person mentioned. These statements are taken as correct in the analyses which follow.[46] The reason for this is that the primary interest here is in the

[46] The same statistical pattern of results emerges no matter whether partially correct statements are taken as correct or incorrect. I note that, with respect to the analyses carried out where partially correct statements are removed, there was a minor inconsistency across Experiments 2A and 2B. Briefly, statements of the form "married to X who is a Y" were counted as correct in Experiment 2A if the first part was correct whereas in Experiment 2B both parts had to be correct. If, however, the statements in question were removed from Experiment 2A the effect of interest would not change, that is, greater recall of the occupational than relational information, since the only effect of reducing the relational content

relative probability of making different types of response, occupational and relational, not in correctness of responses per se.

A final type of statement was that for which I could not determine correctness (these statements I refer to as CV statements, that is cannot verify). There were five statements of this kind in the relational category and three for the occupational category. Note the numbers just given are for trials where the CV statement is the only possibly valid statement for that category. There are other cases of CV statements but these are irrelevant if there is a verifiable statement for the same category to the same item.[47]

3.3.2.2 Computation of Probability

For each participant, and each probe type, I computed the probability of recall for each type of information (occupational, relational) as the proportion of items for which a *correct* response of that type was given. I determined whether a response was correct or not by either common knowledge (for matters such as the occupation of famous people; e.g. that Tony Blair is Prime Minister and that David Beckham is a footballer etc), reference to one of several encyclopedias or by reference to web sites from reputable sources (e.g. official sites such as BBC NEWS).

Following computation of the initial probabilities I then calculated probabilities corrected for misses, miss-attributions and indeterminate responses. This correction is necessary when comparing across probe types since some types have higher miss rates, for example, than other types (see Table 1, above). In the calculation of the corrected probabilities the numerator remains as it is for the uncorrected case, the change is that the denominator is no longer the total number of items in the relevant set but rather the total number of items in the relevant set for which the participant did not miss, make a miss-attribution or make an indeterminate response. This measure is simply the

(i.e. removing the statements in question) would be to increase the magnitude of the occupational advantage.

[47] With respect to the analysis performed with partially correct statements removed: I counted conjunct statements which had some verifiable information along with some that was not verifiable, as being correct if the verifiable element was correct (e.g. "Liam and Paul brothers" in response to a target where I can verify only that Liam is the target's brother but cannot find out about Paul). This does not apply to the analysis inclusive of partially correct responses since the relevant response would be counted as partially correct here anyway, if part of the statement was correct.

conditional probability of participants making a correct certain type of response given that the response is not a miss, miss-attribution or indeterminate response.

3.3.2.3 Mean Probability of Recall

The mean probability of recall, to each probe type, for each class of information is displayed in Table 4 (below). It is immediately apparent that, for all probe types, occupational information is recalled with a much greater probability, on average, than relational information. A two-way ANOVA was applied to the corrected probabilities data set with the following factors: Category (Occupational or Relational; repeated measure) and Probe Type (Face, Name or Semantic; repeated measure). There was a highly significant main effect of Category, $F\,(1, 17) = 74.1, p < .0001$, indicating that participants recalled correct information of an occupational type with a much higher probability than relational information ($\overline{X}_O = 0.91$; $\overline{X}_R = 0.50$). Indeed the amount of total variance explained by the main effect of Category is 56%, which is a substantial amount (the interaction described below accounts for some 2% of total variance, for comparison).

Table 4: Mean probability of recall and one standard error (in parentheses) as a function of class of information recalled, whether corrected or not, and Probe Type, for Experiment 3A.

	Occupational	*Relational*
Corrected		
Face	**0.93** (.056)	**0.47** (.055)
Name	**0.96** (.014)	**0.49** (.040)
Semantic	**0.84** (.029)	**0.53** (.047)
Mean	**0.91** (.021)	**0.50** (.038)
Uncorrected		
Face	**0.75** (.061)	**0.35** (.049)
Name	**0.94** (.015)	**0.48** (.039)
Semantic	**0.71** (.043)	**0.47** (.049)
Mean	**0.80** (.027)	**0.44** (.037)

The only other effect which approached significance ($p = 0.12$) was the two-way interaction between Category and Probe Type. The suggestion of an effect here is due to the smaller difference between the probability of correct occupational versus relational recall for the semantic probe than for the two other probe types. The difference (0.3), however, is still on the order of 5 standard errors. Thus there is no concern that the interaction suggests that the advantage for occupational information is different across the different probe types. That is the important point here. Thus participants have a significantly higher probability of recall for occupational relative to relational information for famous people.

A possible reason, nonetheless, for the suggestion of a different pattern across different probe types would be that, in the semantic probe condition, occupational information is the information used to form the probe, in a majority of cases (87.5% of probes mention prominent occupational information of the target). Thus this information is not likely to be repeated by the participant yet this information is the most well known part of the target's occupation (in order to be a good probe item). Hence we might expect less occupational information to semantic probes.

3.3.3 Discussion

We have clear evidence that the mean probability of recall is significantly higher for occupational information than for relational information, for famous people. This finding replicates previous research on this topic (e.g. Johnson, 1990). For famous people there is a benefit, in terms of probability of recall, which strongly suggests that occupational information is preferentially represented for this class of people.

Is this occupational benefit intrinsic, however, for all sets of people or does it only apply to famous people? The second experiment in this series explores the probability of recall of different types of information for a set of initially unfamiliar soap opera characters which participants gradually learn about over the course of the experiment. I have already stated, at the end of chapter two, the advantages of using an initially unfamiliar soap opera as learning materials and I will not repeat those here. In brief, such materials simply approximate the real-life situation much better than a single image and set of statements. The theoretical interest here is in the structure of participants' person-specific knowledge representations for the learned characters and with how it compares to that seen for famous persons in the previous experiment. The view outlined earlier, moreover, would lead us to expect that the type of information that is preferentially represented (if any) will be that which determines how one primarily *knows* the characters.

3.4 Experiment 3B - Probability of Recall of Occupational and Relational Information for Soap Opera Characters

In the following experiment participants view several episodes of a previously unfamiliar soap opera over five days and are probed for their knowledge of the main characters on day three and day five by means of a cued recall task. The main interest is in the relative probability of recall for different classes of person-specific knowledge, namely relational and occupational. A secondary interest is in how the pattern changes across the two times of testing due to increasing experience with the soap opera. Participants are, as in Experiment 3A, probed for recall by face, name and semantic cues.

3.4.1 Method

Participants

Sixteen undergraduate and postgraduate students at the University of Stirling were paid for their participation in this experiment. All were native speakers of British English and initially unfamiliar with the soap opera materials.

Design & Materials

The main interest in this experiment is in the relative probability of recall of relational and occupational information to soap opera character cues and further in whether this is the same at the two times of testing. Participants viewed ten episodes of an initially unfamiliar soap opera ("Fair City"). Each episode lasted approximately twenty minutes. Participants watched two episodes a day and came back on five successive days. On days three and five, after participants had watched six and ten episodes respectively, they were probed for recall of information about the main characters in the soap opera (the main characters were twelve characters who all appear on screen over ten minutes across the ten episodes).

Thus two factors were manipulated in the present experiment: Probe Type (Face, Name or Semantic; repeated measure) and Time of Testing (Time 1 [after six episodes], Time 2 [after ten episodes]; repeated measure).

The stimuli and recall task were constructed in an analogous manner to that of Experiment 3A.[48] The procedure was also analogous to that of Experiment 3A. Participants were probed by the same set of items at time 2 as at time 1. See Experiment 3B for a list of the semantic probes used.

3.4.2 Results

The key interest in this experiment is in the mean probability of correct recall for relational and occupational information.

3.4.2.1 Classification

For each participant's response set to each item, a correct relational response and a correct occupational response were searched for. This necessitates deciding, beforehand, on what is acceptable as a relational and occupational statement, in the context of the soap opera. The relational category refers to information pertaining to the relations between characters – specifically the family, partner and friend relations (I also include information about who a target person lives with in this category). The occupational category, on the other hand, refers to information pertaining to the work details of characters (I include details such as "housewife", "member of cult").[49]

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[48] Minor alterations were made to two semantic cues early on in the running of the experiment in order to decrease their ambiguity. For one cue the only change was from "is" to "was". The second cue changed from "The person who use to be Lorraine's partner" to "The person who was Lorraine's boyfriend sometime ago". The main analyses were performed both with and without these items present and the same statistical pattern was found each time. Hence theanalyses which follow include these items.

[49] The latter relevant character is a minister for the cult. I also included "has a van" etc for one character whose job involves him driving a van (furniture removal). These are arguable, however.

Simple statements for each category type would be statements such as "daughter Lorraine", "just divorced Bela" and "works with Harry", "is a mechanic", respectively. Importantly statements of the following type are excluded from the relational category, "fancies Eva", "attracted to Lou", since the basis for including statements of this type in the relational category is not clear. Further to the above cases there are also *simple* statements which are *partially correct.* Some examples are: "was engaged to Joanne", "works with his ex-wife", "elected to council" and "with guy who is divorced from work colleague". All of these statements are correct in part but not in whole. For the first example, the target is engaged but not to Joanne, and for the second, the target works with his wife not ex-wife (for the third the target was co-opted not elected, and for the last the target is with the guy who is married to his work colleague). I take partially correct statements as being correct in the analyses which follow.[50]

There are also more *complex* statements such as "very protective of daughter", "getting back together with Jimmy" and "son to Nicola. Always helps her". These statements contain a strong judgement aspect for which it is often difficult to determine correctness. Hence for these statements, where possible, I derive a simple piece of relational information from them (e.g. for the first, the fact that the target has a daughter, for the second, that the person previously went out with Jimmy, and for the third that the target has a son) and concern myself with whether this derived piece of information is correct. Note that while correctness is hard to determine for many of these complex cases considered as a whole, it is not so in all cases.

The final type of response which I want to outline here is that of a partially correct complex statement. Here are a few examples: "doesn't like leaving her son with Helen and Paul", "fighting with current partner over ex-wife". Take the latter example. This is incorrect as it stands since the discussion the relevant characters are having is over the target's wife not ex-wife. Thus the statement is false as it stands since it contains a referential failure. It is partially correct, however, in the sense that one can derive that the target has a current partner from the statement. I treat these statements as

[50] Note that the statistical pattern of effects, using ANOVA, does not change as a function of whether statements which are partially correct (both simple and complex) are included or excluded from the analysis.

the other partially correct above. This is the way in which a complex statement can be determined to be incorrect – if it contains a referential error.

To further complicate matters some complex statements (e.g. "she wants a job") are easy to determine if there is an unambiguous reference, in the soap opera, to the relevant character with the relevant information (e.g. the character herself saying that she wants a job). Thus this latter type can be easily assigned to the correct category in full form. This is of course different from the case where a participant merely surmises that some character wants a job from their actions.

Table 5: Mean probability of correct name recall, miss and miss-attribution for each probe type and each time of testing with one standard error in parentheses (Experiment 3B).

Time of Testing	*Time 1*			*Time 2*		
	Name	Miss	Missat.*	Name	Miss	Missat.*
Probe Type						
Face	**0.42** (.084)	**0.016** (.016)	**0.016** (.016)	**0.75** (.076)	**0.016** (.016)	**0.00** (0)
Name	**NA^**	**0.13** (.051)	**0.063** (.028)	**NA^**	**0.016** (.016)	**0.016** (.016)
Semantic	**0.33** (.067)	**0.22** (.045)	**0.016** (.016)	**0.69** (.074)	**0.047** (.034)	**0.00** (0)
Mean	**0.38** (.056)	**0.12** (.025)	**0.031** (.010)	**0.72** (.060)	**0.026** (.013)	**0.0052** (.005)

* Missatt = miss-attribution. ^ NA = not applicable.

3.4.2.2 Measures of Learning

Before reporting on the main results of interest I first consider some general measures of performance. I consider three such measures. These are the probability of correct name recall, the probability of a miss (defined as a trial where the participant recalls no information to a given item), and the probability of a misattribution (defined as a trial where a participant misidentifies the target item as being someone else from the soap opera). Each of these probabilities is computed independently for each participant, for each probe type and each time of testing. Table 5, previous page, displays the relevant quantities. I will report on three separate analyses, one with each of these measures as the dependent variable. The reason for performing these analyses is just to confirm that participants are indeed learning as they view more episodes of the soap opera. If that is the case then we should observe an increase in the probability of correct name recall across the two periods of testing (unless optimum performance has been reached at time 1), and a decrease in the probability of making both a miss and a misattribution across the two periods of testing (with the same caveat as before for these latter two measures). Indeed the *differentiation* model of McLelland and Chappell (1998) would predict just such a change in performance.

A two factor ANOVA was applied to the probability of miss data with the following factors, Probe Type (Face, Name or Semantic; repeated measure) and Time (Time 1 or Time 2; repeated measure). This analysis revealed a significant main effect of Time, $F\,(1, 15) = 15.4, p = .0014$, showing that participants made less misses at time 2 than time 1 ($\overline{X}_{T1} = 0.12$; $\overline{X}_{T2} = 0.03$). There was also a main effect of Probe Type, $F\,(2, 30) = 4.23, p = .0240$. The interaction was also significant, $F\,(2, 30) = 8.56, p = .0011$, showing that less misses were made for name and semantic probes at time 2 than time 1 but that there was no difference for face probes ($\overline{X}_{FT1} = 0.02$; $\overline{X}_{FT2} = 0.02$; $\overline{X}_{NT1} = 0.13$; $\overline{X}_{NT2} = 0.02$; $\overline{X}_{ST1} = 0.22$; $\overline{X}_{ST2} = 0.05$). Thus less misses are made at time 2 than time 1, but only for the name and semantic probes.

The same ANOVA model applied to the probability of misattribution data, moreover, shows no significant effects. Two effects are, however, marginally non-significant, the main effect of Time ($p = 0.056$; $\overline{X}_{T1} = 0.03$; $\overline{X}_{T2} = 0.005$) and the main effect of Probe Type ($p = .099$; $\overline{X}_{F} = 0.008$; $\overline{X}_{N} = 0.04$; $\overline{X}_{S} = 0.008$). These non-significant effects are suggestive, respectively, of the fact that participants make less misattributions at time 2 than time 1 and that the probability of making a misattribution is larger for name probes than the other two probe types.

A two-way ANOVA with the following factors, Probe Type (Face or Semantic; repeated measure) and Time (Time 1 or Time 2; repeated measure), was carried out on the probability of correct name recall data. The main effect Time was significant, $F\,(1,$

15) = 37.04, $p < .0001$, indicating that there was a significantly higher probability of correct name recall at time 2 than at time 1 ($\overline{X}_{T1} = 0.38$; $\overline{X}_{T2} = 0.72$). This did not differ due to probe type. Thus the probability of correct name recall was the same for the face and the semantic probes.

The important points to summarise, then, are that participants have a lower probability of making a miss for both name and semantic cues at time 2 relative to time 1, which suggests learning has taken place. The probability of making a misattribution also decreases across learning though the effect is not quite significant. Further the probability of correct name recall increases across learning, as we would expect. Thus participants do seem to be learning while viewing more episodes of the soap opera.

In contrast, however, with the experiment using famous person cues (Experiment 2A), where name cues were found to be best (in terms of lowest probability of missing), the present experiment finds name cues to be worse, along with semantic cues, than are face cues. Some thought reveals that this may be due to the fact that the soap opera is Irish and as such some of the names are harder to learn than would be the case if it were English.

Table 6: Mean probability of recall and one standard error (in parentheses) as a function of Probe Type, Time of Testing, class of information recalled, and whether corrected or not, for Experiment 3B.

Time of Testing	*Time 1*		*Time 2*	
Class of Information	OCC	REL	OCC	REL
Corrected				
Face	**0.77** (.040)	**0.85** (.047)	**0.85** (.052)	**0.98** (.016)
Name	**0.70** (.072)	**0.96** (.025)	**0.86** (.040)	**0.97** (.021)
Semantic	**0.61** (.096)	**0.87** (.054)	**0.77** (.077)	**0.91** (.044)
Mean	**0.70** (.046)	**0.90** (.0025)	**0.83** (.035)	**0.96** (.020)
Uncorrected				
Face	**0.75** (.046)	**0.83** (.050)	**0.84** (.055)	**0.97** (.021)
Name	**0.59** (.068)	**0.78** (.060)	**0.83** (.044)	**0.94** (.036)
Semantic	**0.47** (.075)	**0.67** (.063)	**0.72** (.075)	**0.88** (.056)
Mean	**0.60** (.040)	**0.76** (.039)	**0.80** (.032)	**0.91** (.023)

3.4.2.3 Mean Probability of Recall

Uncorrected and corrected probabilities were computed in the same manner as described for Experiment 3A, which gives a probability (corrected or uncorrected) here of correct recall for each participant, at each time of testing, for each probe type and for each category. The mean probability of recall for each of these divisions is shown in Table 6 (previous page).

A three-way ANOVA, with the following factors, Time (Time 1 or Time 2; repeated measure), Category (Relational or Occupational; repeated measure) and Probe Type (Face, Name or Semantic; repeated measure) was applied to the data in the form of corrected probabilities. This analysis revealed a significant main effect of Time, F (1, 15) = 11.9, p = .0035, thus demonstrating that the probability of making a correct response increases over the course of the learning period ($\overline{X}_{T1}$ = 0.80; $\overline{X}_{T2}$ = 0.89). The main effect of Category, furthermore, was highly significant, F (1, 15) = 33.0, p < .0001, indicating that there was a higher probability of making a correct response of the relational as opposed to the occupational type ($\overline{X}_{R}$ = 0.92; $\overline{X}_{O}$ = 0.76). The main effect of Category accounts for about 12% of the total variance in the dependent variable (for comparison the only other significant effect, the main effect of Time, accounts for only about 4% of the total variance using the same measure). No other effects were significant (all p's > 0.1).

Thus the analysis shows, most importantly, that there is a greater probability of recall for relational as opposed to occupational information, for the tested set of soap opera characters. This pattern is, moreover, the reverse of that observed for the famous people in Experiment 3A. Furthermore no significant differences in this pattern are observed as a function of the different probe types or time of testing.

3.4.3 Discussion

In contrast to the results for the famous set of people (Experiment 3A) the present results demonstrate that relational information has a significantly higher probability of recall for the soap opera characters than occupational information. Thus the pattern is reversed compared to that for the famous people. Thus we have evidence that occupational information is not the most preferentially represented type of person-specific knowledge for this set of soap opera characters. Rather relational information seems to be preferentially represented. I can, moreover, dispel any notion that there is some intrinsic benefit for processing of occupational information for all classes of people. If that were the case we would have expected to obtain an occupational advantage in the above experiment.

An interesting question to consider is the source of the relational benefit for the soap opera characters. The view outlined in the introduction as an explanation for the occupational benefit seen for famous people would suggest that relational information is experienced to a greater degree with these soap opera characters than occupational information. Thus what would be useful here is some measure of the content of the soap opera (in terms of relational and occupational focus). This, however, is difficult to devise.

I have shown reliably different patterns of information benefit for famous people and soap opera characters in terms of probability of recall. I now attempt to find converging evidence from a verification paradigm. If one type of information is preferentially represented, as indicated by recall, then I would expect (on the simplest model) the benefit to extend to speed of verification for the relevant type of person-specific knowledge. That is, if occupational information is recalled with the highest degree of probability to famous people then it should also be verified more speedily than any other type of person-specific knowledge, for the same class of people. (Analogous arguments hold for the soap opera characters.) Experiment 3C investigates speed of verification of both relational and occupational information for a set of famous people while Experiment 3D does likewise for a set of soap opera characters.

3.5 Experiment 3C – On the Verification of Occupational and Relational Information for Famous People

In the following experiment I investigate the processing of relational and occupational information about famous people in an on-line task. I have established that participants recall occupational information to such people with a much higher probability than relational information (Experiment 3A). What consequence does this have for on-line processing of occupational and relational information about famous people? Previous research (e.g. Johnson & Bruce, 1990; Young, McWeeny, Hay, & Ellis, 1986a; Young, McWeeny, Ellis & Hay, 1986b) has found that occupational information is processed faster than any other type for famous people (though we are not aware of any previous attempts at direct comparison between occupational and relational information). I would expect, however, occupational statements to be verified faster than relational statements in this experiment given the explanation of the benefit outlined earlier.

3.5.1 Method

Participants

Sixteen undergraduate and postgraduate students from the University of Stirling and the University of Glasgow participated in this experiment. All were native speakers of British English.

Apparatus

Participants were individually tested in the Psychology labs at the University of Glasgow on a Macintosh G4 laptop using the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993).

Design & Materials

The main interest in this experiment is in the response latencies to occupational and relational statements about famous people. On each trial, participants made a true / false decision to a face-statement pair. One experimental factor, Type (True Relational or True Occupational) was manipulated within participants.

Ten famous people were selected for use in the current experiment. A single face image for each person was obtained (the same image for each famous person appears in each condition of the present experiment). All images had the on-screen dimensions of approximately 6.2 cm by 5.6 cm and were centred on-screen. Statements were displayed in bold Helvetica font, pt. size 30, centred beneath the image.

Four statements were created for each person (see Appendix 3A). One statement referred to the true *occupation* of the individual (e.g. for Tony Blair: "Prime Minister?"); statements of this type formed the true occupational condition. A second statement pertained to the true *relations* of the person (e.g. "is married?"); statements of the second type formed the true relational condition. To balance the experiment, two matching false statements were also created for each person (one of which was false occupational [e.g. "is a waiter?"] and the other false relational [e.g. "has a niece?"]).

Four conditions were thereby created: true relational, true occupational, false relational and false occupational, each of which consisted of ten face-statement pairs, one for each famous person in each condition. There were thus forty trials in this experiment, half of which were true and half of which were false. Statements in each condition were matched on the basis of word and letter count (see Appendix 3C for a table of mean values).

Procedure

Participants were seated approximately 50 cm from the computer monitor. They were instructed to attend to the fixation cross and to make a True / False decision to each face and statement pair ("Is the question true or false with respect to the face with which it appears?"). Participants were instructed to press (on the keyboard) the 'A' key for "False" and the 'L' key for "True". A trial consisted of the presentation of a fixation cross for 250 ms, followed by a face-statement pair, which was on-screen until the participant responded. A delay of 500 ms was interposed between each trial. The experimental trials were preceded by several practice trials (utilising images of different famous people) in order to orient participants to the correct keys for responding.

3.5.2 Results

Mean median response latency for the conditions of interest are shown in Table 7 (below). Participants verified true occupational statements as being true significantly faster than true relational statements, t (15) = 4.98, $p < 0.001$. A similar pattern emerges when the accuracy data is considered. Mean percentage correct is significantly higher for true occupational statements than for true relational statements, t (15) = 2.82, $p = 0.013$. Thus true occupational statements are both verified faster and more accurately than true relational statements for famous people. I do not consider the pattern on false statements since these statements are simply filler items in the task and further some of these items are quite difficult to answer (subjectively the patterns seem to be similar).[51]

Table 7: Mean median response latency (R.L), one standard error (S.E.) and mean percentage correct (P.C.) to famous face-statement pairs in the verification task of Experiment 3C.

Condition	*Mean Median R.L*	*1 S.E.*	*P.C.*
True			
Occupational	1032	30	96.9
Relational	1241	59	86.9
False			
Occupational	1220	41	95.6
Relational	1410	73	80.0

3.5.3 Discussion

Thus, on a face-statement verification task, occupational statements are responded to reliably more speedily and more accurately than relational statements, for famous people. This result is in line with previous research concerned with speed of processing of different types of information for famous people (e.g. Johnson & Bruce,

[51] I do acknowledge of course that how participants process false statements may well influence how they process true statements. Some false relational statements, for instance, were quite difficult to answer. An improved approach, however, might be to use false items such as were used in Experiment 2A (e.g. " has wings") with no relational and occupational differentiation. I do not believe, however, that such a change would alter the main finding here.

1990) and extends the previous work by directly comparing speed of occupational processing with that of relational processing. Thus, this experiment adds further support to the idea of preferential representation of occupational information for famous people (though see section 3.7.3).

The explanation for such preferential representation of occupational information is simply the differential experience which participants have with famous people with this type of information as compared to other types of person-specific knowledge. One question that arises from the work reported so far is exactly how the higher probability of recall for occupational information relates to the faster processing of such information, for famous people. Furthermore, the above explanation simply assumes that occupational information is more frequently experienced with famous people and thus it would be desirable to show that this is indeed the case. I will elaborate on this in the general discussion.

I now move to report the final experiment in the current series. Does relational information seem to be preferentially represented for the soap opera characters as measured by speed of response in a verification task?

3.6 Experiment 3D – On the Verification of Occupational and Relational Information for Soap Opera Characters

In the following experiment I investigate the processing of relational and occupational information about soap opera characters in an on-line task. I have established that participants recall information about a character's relations with a higher probability than information about their occupation (Experiment 3B). What consequence does this have for on-line processing of relational and occupational information about these same characters?

3.6.1 Method

Participants

Sixteen undergraduate and postgraduate students from the University of Stirling participated in this experiment. All were native speakers of British English and in addition were initially unfamiliar with the soap opera materials.

Apparatus

Participants were individually tested in the Psychology labs at the University of Stirling on a Macintosh G4 computer using the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993).

Design & Materials

The aim of the current experiment was to compare participants' response latencies when making decisions to occupational versus relational statements about given characters from the soap opera. On each trial, participants made a true / false decision to a face-statement pair. One experimental factor, Type (True Relational, True Occupational) was manipulated within participants.

Participants viewed ten episodes of a previously unfamiliar soap opera over five days (watching two episodes per day). On the fifth day, after viewing that day's two episodes, participants performed the statement verification task. Ten characters from the soap opera (Fair City) were selected for use in the current experiment (all appeared on-screen over 10 minutes across the ten episodes). The remaining specifics of the design, and the procedure, were the same as for Experiment 3A. Thus statements in each condition were again matched on the basis of word and letter count (see Appendix 3D for a table of mean values).

A control experiment, furthermore, was carried out to confirm that any differences found in the main experiment could not be explained as being due to factors merely influencing statement recognition across the different conditions. The control experiment involved participants processing all of the statements used in the current experiment plus the same statements presented in a jumbled-up format (e.g. "is a music artist?" Vs "music a is artist?", the latter statements simply creating the task demands). Participants had to decide whether each statement was grammatically correct or not. This control experiment showed, for the processing of statements in their grammatically correct form, no difference between processing of true occupational or true relational statements, but there was a trend towards a difference between processing of false occupational and false relational statements, with processing of false relational statements taking less time. The critical point here, however, is that no difference was found between the processing of true relational and true occupational statements on this grammar judgement task suggesting that these conditions are equivalent with respect to factors influencing statement recognition.

Table 8: Mean median response latency (R.L), one standard error (S.E.) and mean percentage correct (P.C.) to soap opera face-statement pairs in the verification task of Experiment 3D.

Condition	*Mean Median R.L*	*1 S.E.*	*P.C.*
True			
Occupational	1376	92	92.5
Relational	1418	71	95.6
False			
Occupational	1324	95	98.8
Relational	1677	112	98.1

3.6.2 Results[52]

Summary statistics for the four conditions are shown in Table 8 (previous page). A related samples t-test found the difference between the mean of median response latency in the occupational and relational true conditions to be non-significant, t (15) = 0.81, $p = 0.431$. The same pattern was displayed with accuracy as the dependent variable, t (15) = 1.05, $p = 0.312$. Thus response latency and response accuracy are non-reliably different across the occupational and relational true conditions. There is no benefit, for the soap opera characters, in verifying as true relational versus occupational information. Once more, I do not consider the pattern on false trials since these were merely included as filler items (though I note that there appears to be an advantage for rejecting false occupational statements).

3.6.3 Discussion

The current experiment reveals no significant differences between the verification of occupational versus relational information for the soap opera characters (on either response latency or response accuracy). Thus, most importantly, occupational information does not seem to be preferentially represented for these soap opera characters (if it had been we would have expected at least significantly faster processing of this type of information) and hence it seems very unlikely that there is some intrinsic benefit to occupational processing for all types of people. Further the fact that participants recall information of a certain class (relational) with a higher probability does not seem, on the surface, to facilitate making speeded responses to questions of this class (though I note this differs with the previous results on famous people). Thus, in contrast to the results for famous people, which showed a consistent benefit for occupational information over relational information, the results for the soap opera characters diverge across the two experiments.

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[52] One of the items was phrased incorrectly ("was a shopkeeper" as opposed to "is a shopkeeper", the latter being correct). Thus responses to this item were replaced by the mean of each participant's responses to the other items in this condition (and by the median in another analysis). No significant effects were discovered either by-items or by-participants on RL. In addition, no effects were found on accuracy when all the incorrect responses to this item were replaced with correct ones. Thus this item does not seem to have a large bearing on the results.

One point to note is that a latency advantage in the verification task may simply not have materialised as yet. We must remember, when comparing the results for the famous people with that for the soap opera characters, that the amount of experience which participants have of each class of people is widely different. At this point I cannot answer the question of whether more experience of the soap opera (and hence the characters) would lead to the development of a processing bias on latency towards relational information though it would be an interesting question to pursue. Another reason, however, relates to the relative distinctiveness of the statements in the relational and occupational condition of this experiment. I elaborate on this in the General Discussion.

3.7 General Discussion

The results from the present series of experiments can be summarised as follows. First, for famous people, the results on probability of recall (Experiment 3A) strongly suggest that occupational information is preferentially represented for such people. The results on verification (Experiment 3C), for famous people, add further support to this view (though see section 3.7.3). Second, for the set of soap opera characters, the results on probability of recall strongly suggest preferential representation of relational information. The results of the verification task for the soap opera characters, however, do not speak directly to the issue of preferential representation for reasons outlined below. Third, we can conclude that occupational information does not have an intrinsic preferential representation for all classes of people (all experiments). This leaves open what is the main determinant of preferential representation in the representation of person-specific knowledge.

The discussion is organized around the following three main areas. First, I consider a more detailed explanation of why occupational information is preferentially represented for famous people. Secondly, I present arguments and some evidence in support of the position that it is the statistical structure of the environment to which participants are exposed that determines preferential representation, and hence their responses on recall and verification tasks. I then consider some important points that can be gleaned from the differing patterns of results for the soap opera characters across the two tasks.

3.7.1 A More Detailed Explanation of the Occupational Benefit for Famous People

An analysis of environmental structure (e.g. Anderson, 1990; Schooler & Anderson, 1997) would most likely indicate, I conjecture, that when encountering a famous person in daily life (in a newspaper or on a website, for instance) occupational information about that individual is more likely to be present in the context than other types of information. Thus when encountering the name of Tony Blair, for instance, the occupation "Prime Minister" would be in the immediate context with a high probability whereas his wife (Cherie Blair) would be in the context with a much lower probability.[53] If we make the further assumption that people become sensitive to the structure of the environment to which they are exposed (which seems unproblematic) we can then explain how the benefit arises.

Stimulus conjuncts (e.g. Tony Blair & Prime Minister) encountered in the environment with a higher frequency will be represented in a more *differentiated* manner (see McClelland & Chappell, 1998). Further such conjuncts will, critically, possess a greater co-occurrence value than those encountered with less frequency. That is, the probability of encountering the occupation Prime Minister, given Tony Blair is in the context, is likely to be much higher than the probability of encountering Cherie Blair (or the fact that he is married) under the same conditions. Thus there would be a stronger co-occurrence link between Tony Blair and his occupation than between himself and his relational information. There would be a more refined, robust representation for the conjunct which is encountered more often.

Thus participants would recall the occupation "Prime Minister", when presented with Tony Blair's face or name as a cue, with a much higher probability than, say, the

[53] Note that this pattern will not necessarily be the case for all famous people. I am just arguing that it is likely to be the case for most of them. A case of the converse would be Victoria Beckham, who is now mostly mentioned in the media in her role as being David Beckham's wife.

fact that he is married (and, in addition, process an occupational statement faster than a relational one). The environmental structure to which participants are exposed would hence determine the structure of their responses on verification and recall tasks.

3.7.2 The Main Determinant of Preferential Representation

A simple explanation of preferential representation, as outlined above, is in terms of the differential experience which participants have of a given class of people with different types of information. Thus both probability of recall and speed of verification would be functions of one underlying variable. The variable would be some measure of experience in terms of the robustness, or level of differentiation, of the representation. Probability of recall would be positively related to this variable whereas speed of verification would be negatively related. The precise form of these relationships is out with the scope of the present thesis (see, however, Anderson & Milson, 1989).

Thus the reason why participants are faster to make occupational decisions to famous people and recall such occupational information with a higher probability would be that such information is experienced (or required) more often with famous people. Thus when we encounter David Beckham or Tony Blair, more often than not we will encounter them in an occupational context. Perhaps the occupation of each will be part of the context or perhaps such information will not be directly part of the context but will be required to understand the present scenario.

A simple, preliminary, analysis of the statistical structure of the environment will, I think, show this to be the case (see Anderson & Schooler, 2000; Schooler & Anderson, 1997, for the inspiration for this work). I present the results of such an analysis in Table 9 (next page).[54] The environmental source which I used here was the Guardian newspaper website archive (searching from 1st Sept 1998 to April 17th 2004). For a selected subset of famous people (e.g. David Beckham) I present the probability

[54] The specific occupational properties were as follows: for Tony Blair, Prime Minister; for David Beckham, football; for Bill Clinton, President; and for Andre Agassi, tennis. The specific relational properties were as follows: for Tony Blair, Cherie; for David Beckham, Victoria; for Bill Clinton, Hillary; and for Andre Agassi, Steffi, and Brooke (I simply summed the searched for these latter two though this will tend to overestimate the true number).

of encountering each individual's occupational information (e.g. football) being in the context (defined as being in the same entry) given that the story mentions the famous person, and in the next column the probability of encountering each individual's relations (e.g. Victoria Beckham) given that the story mentions the famous person. We can clearly see that the probability of encountering the occupation of the famous person given that the person is in the context is much greater than the probability of encountering the person's relations under the same conditions. Indeed, on this analysis, the occupational information is between about 6 and 16 times more likely to be encountered along with the famous person than is the relational information.

Table 9: Number of entries found in the Guardian website archive for a certain famous person under several conditions and conditional probabilities of encountering a certain selected occupational and relational property, respectively, for each person (see text and notes under table for fuller explanation).

	N (X)^	N (X & O)*	N (X & R)`	P(O|X)+	P(R|X)-
Famous Person (X)					
Tony Blair	29,742	14,658	908	0.49	0.03
David Beckham	4841	3628	420	0.75	0.09
Bill Clinton	4387	3168	331	0.72	0.08
Andre Agassi	869	761	132	0.88	0.15

^N (X) = total number of entries.
*N (X & O) = total number of joint X and selected occupational property entries.
`N (X & R) = as above except with a selected relational property.
+P(O|X) = conditional probability of encountering occupational property given the target is in the context.
-P(R|X) = conditional probability of encountering relational property given the target is in the context.

Clearly my preliminary analysis needs to be improved upon. For one I have utilised only four famous people. Moreover, only one source has been searched. Furthermore only *selected* occupational and relational properties have been used. Consider the example of Tony Blair, the occupational property was "Prime Minister", which does not capture entries where his role is not explicitly mentioned yet necessary for understanding the entry. Further the relational property was "Cherie", Tony Blair's wife. This excludes the entries where his children are mentioned independently (though I would not expect there to be many of these cases). Thus the measure that I have used here is very rough and a much simplified approximation.[55] In addition, for the two sportspeople, the occupational property I have searched for is not their actual occupation, which would be "footballer" and "tennis player" respectively, but the more generic "football" and "tennis". I do this since most of the stories mentioning these people will be in a sports context. Presumably, if one is talking about the Wimbledon tennis championship, and specifically the results of a match between two competitors, then one does not have to explicitly say that the competitors are tennis players. This is clear from the context. This is in contrast, however, to many stories about politicians, where they are generally introduced along with their title.

There is, furthermore, the issue of selection bias with respect to the *type* of source which I have searched. I have searched only an online broadsheet newspaper source. Would the pattern differ if I searched *Hello* magazine, for instance? While the magnitude of the difference between occupational and relational exposure may well decrease in such an analysis I would expect the fundamental occupational advantage to occur, on average, across a whole range of sources. I think a much broader analysis should be carried out utilising a range of different types of source whilst giving due consideration to average levels of experience with each type of source.

Thus if these results are generalisable, which I believe them to be, this would be support for the view that participants are differentially exposed to different classes of person-specific knowledge alongside famous people in the environment. This would lead to a better developed representation for the famous people with occupational rather than relational information. That is, for the conjunct with the stronger co-occurrence link.

From the above, it is not much of a leap to suggest that participants' preferential representation of occupational information for famous people is due, in the main, to the increased levels of experience with such information for this type of person. Of course I

[55] There are other problems too. For instance, the relational terms searched for are typically names, which are more precise in their referents than are generic terms such as "prime minister" or "tennis".

cannot yet conclude that this increased experience is causing the preferential representation but it seems the most likely potential cause of the benefit. Future work should causally manipulate level of experience to given classes of information whilst participants are learning about new people and measure both probability of recall and speed of verification to such information at regular intervals throughout learning. This may go some way to resolving the question.

There is, in addition, the important question of individual differences in knowledge representation for famous people. The environmental analysis above suggests that occupational information will be experienced alongside famous people more often than relational information but of course a given individual may only know about a given famous person through a restricted subset of the available sources (or may only focus on a subset of the available information within one given source). Someone may know about Andre Agassi mostly in terms of the women he has dated and not much about his tennis career. Thus it would be most interesting to conduct a study correlating individual participant experience of a given person (i.e. which type of knowledge does the participant primarily know the famous person through) with performance on recall and verification tasks. The current theoretical view would predict that the type of information at an advantage on such tasks would be that with which participants have had most experience, for any given famous person. The main point, however, is that on the average occupational information is at an advantage for famous people.

Finally, another productive avenue of research may be to examine recall and verification performance for a set of standard famous people (i.e. actors and politicians) with that for a set of pre-existing well-known soap opera characters (i.e. the characters from Eastenders). The actors who star in Eastenders, for instance, may lead to a knowledge representation focused in large part on relational information about their character's roles rather than about the fact of them being an actor. The point here is that we do not really know much about many of these kind of actors, other than in their roles in the soap opera. This is most different to the standard famous people usually employed in such experiments.

3.7.3 Recalling Versus Verifying Information – Explaining the Different Patterns for the Soap Characters

We have established clearly that relational information has a higher probability of recall than occupational information for the soap opera characters. This strongly suggests that relational information is preferentially represented for this class of people. The verification task, however, does not reveal a difference in the processing of relational and occupational information for this set of characters even though we may well have expected one based on the recall task results. There is a critical factor, however, which was not controlled in the verification experiment and is missing from the analysis so far. This factor reduces any weight that the verification task has in speaking to the issue of knowledge representation for the soap characters.

This is the question of the relative distinctiveness of the occupational and relational statements in the verification task.[56] By *distinctiveness* I am referring to how many people share a given attribute within some set of people (with lower numbers the attribute is more distinctive). By *relative distinctiveness* I am referring to the distinctiveness of one set of statements (e.g. occupational) relative to another set of statements (relational) for a given set of people. I made no explicit attempt to control this variable in either verification task. Thus the reason for the differential pattern of results between the recall and verification tasks for the soap characters may not reflect a matter of knowledge representation per se but rather may reflect task-based access to this knowledge. That is, the knowledge representation for the soap opera characters may well be biased in favour of relational information, as the recall experiment indicates, but no advantage accrues to relational information on the verification task since the distinctiveness of the statements interacts with this representational bias. Occupational questions about the soap opera characters may be easier to answer than relational questions, due to greater levels of distinctiveness, in the verification task.

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[56] I do not consider this from the point of view of the recall task since, A) even if this is a factor on the recall task it would only be so for the semantic probe condition (that is, one third of the trials), and B) even if an occupational probe is more distinctive than a relational probe this does not mean that the pattern of recall (the relative probability of recalling information of each type) would differ due to distinctiveness. As support for this position no significant interaction was observed between Category (Relational or Occupational) and Probe Type (Face, Name, or Semantic) in Experiment 3B.

This may then reduce the latencies to respond to the occupational statements to the same level as for the relational statements.

Thus the reason why I detect no benefit for relational processing of the soap opera characters in the verification task may simply be that the relational statements are less distinctive than the occupational statements and therefore are processed more slowly than they would be if distinctiveness were equivalent across the two sets of statements. A simple comparison of statements used in the occupational and relational true conditions for the soap opera characters reveals that there does seem to be a greater distinctiveness, within the full set of soap opera characters, for the occupational statements (that is, the properties mentioned in such statements tend, on the average, to be shared by less characters than relational statements). Thus this factor should be controlled in any future experiment of this sort.

Thus Experiment 3B demonstrates that relational information is recalled with a higher probability than occupational information for the soap opera characters and hence preferential representation of such information. Experiment 3D, on the other hand, does not speak to preferential representation of relational information either way (i.e. for or against). Before such statements could be made Experiment 3D would have to be replicated with distinctiveness controlled across the sets of relational and occupational statements. This does, furthermore, provide a general warning as to the difficulty of interpreting verification task results without knowledge of the average distinctiveness of each set of statements employed.

Of course, someone may well ask does not this qualification also apply to the famous person verification task (Experiment 3C). The answer is that it does in the sense that no attempt was made to control relative distinctiveness there either. The critical thing to note here, however, is that occupational information has already been shown, independently, to be at an advantage for famous people. It is also important to note that the verification results agree with the results on probability of recall, for famous people and both are in line with the theoretical outline given here. These considerations make it unlikely, in my view, that the famous person verification results are solely due to differing distinctiveness levels of the occupational and relational statements.

Occupations do tend to be more distinctive than relations and this will lead, in a verification task, to some advantage for occupational processing for any set of people. In the present series of experiments, this has led to the significant benefit for relational information on recall, for the soap characters, to be rendered non-significant on verification. For the famous people, in contrast, the significant occupational benefit on recall is, presumably, strengthened on the verification task.

In addition to the problem of relative distinctiveness there are several other potential reasons for the differing patterns of results for the soap opera characters. First, to be able to directly compare performance for these characters with that for famous people we need to know relational information is indeed experienced more often than occupational information with the soap opera characters (this seems to be suggested by the results on probability of recall but we need to objectively determine the fact – as I have attempted in a preliminary manner for famous people). Second, we also need to try and estimate the relative magnitude of the difference in each case between the amount of occupational and relational experience. Finally, the amount of experience with each type of people should also be determined.

Thus it could be that the latency effect, A) requires more experience with the given class of people to surface than the recall effect, and, or, B) requires a greater magnitude of difference between the amount of experience with occupational and relational information to arise than the recall effect. Thus the precise mapping between the underlying variable (robustness of representation) and each of the dependent measures would have to be different for each or else where we find an effect on one measure we should find it on the other.

Both of the factors suggested above could be manipulated in a future experiment to determine whether it is likely that they are responsible for the present pattern of results. One could investigate the initial occurrence of the recall and latency effects to establish whether they are simultaneous or happen in some order. One could also manipulate the magnitude of the difference between the amount of relational and occupational information learned and investigate the effect which this has on the onset of the recall and latency effects.

From the soap opera data on probability of recall there is an effect size of about 1.1 (for time 2, which is the same time as when participants perform the verification task), whereas for the famous people the comparable effect size is 1.89. Thus the effect size is a good bit larger for famous people and this probably reflects a greater magnitude of experience with occupational over relational information for this class of people. For the soap opera characters, on the other hand, the effect size is much smaller perhaps indicating less of a difference in the magnitude of relational over occupational information for this set of people. Thus different levels of experience with the relevant types of information may be responsible for why the latency effect occurs for the famous items yet not for the soap items. Of course, none of these suggestions preclude the hypothesis that relative distinctiveness is the critical factor here.

One general point remains to be considered. What of the finding, reported in the introduction, that for unfamiliar person learning tasks, occupational information is the most accurately recalled even though the number of repetitions of such information is equivalent with that for the comparison types of information (e.g. names and pets; Cohen, 1990). My answer to this question is that the responsible factor is probably the *distinctiveness* of the pieces of information given to the participant to associate with the unfamiliar face. Further the *ease of remembering* may also play a role. These two factors are not independent. Consider being told to try and learn that an unfamiliar face is that of a Mr Hobbs, who is a pilot, and who has a dog (the example is from Cohen, 1990). I would argue that the fact that the person is a pilot is the easiest attribute to base one's memories for this individual on. The fact that he has a dog is not so central a quality of the person as their occupation. Further, how many people actually know pilots as opposed to know people with pets? The distinctiveness of the former seems greater (unless obscure pets are used). The same distinctiveness criteria would apply if relational information were to be included in a future experiment of this type. Thus if I had to learn that Mr Hobbs was a pilot and was married then since I know many people who are married but none (or few) who are pilots I would expect the former type of information to result in better performance. There are two issues here: first, for each type of information to be remembered how central is it to our general conception of a person and how does this influence our ability to remember the information (here I am arguing that being a pilot, or having a certain type of occupation is more central than having a pet). Second, how do the different types of information differ in terms of distinctiveness (here I am arguing that certain types of information may be more distinctive and that may lead to better performance on such information). Thus I think that these two factors are needed to explain the sorts of results seen on this type of learning paradigm.

3.7.4 General Conclusions

For famous people, occupational information is recalled with the highest probability whereas for a set of soap opera characters, in contrast, relational information is recalled with the highest probability. Moreover, for famous people occupational information is verified faster than relational information whereas for the soap opera characters I found no difference in the processing of occupational and relational information. Thus, the experiments reported in the present chapter have demonstrated that occupational information does not possess some intrinsic benefit, in terms of processing, for all sets of people. Furthermore I have attempted to explain preferential representation for a given type of information and set of people as being due to the differential experience accrued with that person and that information. Preferential representation, then, seems likely to be determined by the structure of a perceiver's environment and hence their responses on recall and verification tasks. The analysis offered sits well with that of Anderson (1990; Anderson & Schooler, 2000) whose work is the main inspiration for the view here given.

Chapter 4

On the Perceptual and Semantic Familiarisation of Initially Unfamiliar Soap Opera Characters

4.1 General Introduction

In this chapter I explore participants' learning of previously unfamiliar soap opera characters (that is the process of *familiarisation* of new people). I compare task performance for these previously unfamiliar characters with that for a set of well-known famous people. I use a self-priming paradigm (e.g. Calder & Young, 1996) and test participants on several days while they learn about these soap opera characters. The objective is to provide some initial evidence as to the perceptual and semantic familiarisation of initially unfamiliar people. That is, to provide evidence on the formation and development of perceptual and semantic representations for new people. To foreshadow, perceptual familiarisation and semantic familiarisation are both successfully induced in a learned population of items, for the first time. Perceptual familiarisation, in addition, is explainable by current models of human memory (e.g. McClelland & Chappell, 1998; Logan, 1988, 1990). Further theoretical development will be required, however, to satisfactorily explain the results on semantic familiarisation. Several recommendations for future research in this area are offered.

4.2 Overview of Familiarisation

In the introductory chapter (Chapter 1, section 1.3.1) I established that differences exist in the processing of familiar and unfamiliar people (relying on evidence from research on face processing). I also reviewed the scant evidence available on the processes of familiarisation itself (Chapter 1, section 1.3.2). I now offer a summary of important points from the introductory chapter pertinent to familiarisation before proceeding immediately to examine and justify the specific paradigm I chose to use in these experiments.

The important points about familiarisation are that, first of all, differences abound in the processing of familiar and unfamiliar faces. Thus some change must take place in one's representations or processing of a given face as that face changes from being unfamiliar to familiar. This change is the process of familiarisation. Second, attempts to study familiarisation to date have focused on simple perceptual familiarisation and thus have not included any serious attempts at studying semantic familiarisation. The experiments reported in the present chapter attempt to directly study semantic familiarisation. A further point is that the ecological validity of the materials used in the familiarisation studies carried out to date has been questionable. I utilise more naturalistic stimuli than has been used previously. The central problem of familiarisation then, is to explain the changes that occur in the processing and representation of initially unfamiliar people as they become familiar. What changes in the representation of semantic information and of perceptual information occur during familiarisation?

The aim of the experiments reported in the present chapter is to investigate the processes of familiarisation in an implicit, on-line manner. Participants watch episodes of a previously unfamiliar soap opera and hence become familiarised with the characters of the soap opera in a semi-naturalistic manner. Participants are tested at regular intervals throughout the learning period on a self-priming task (a form of associative priming; see the next section) and I attempt to infer, from test performance, the state of the participants' internal representations, for the newly learned items, at each point of testing. This allows the tracking of changes in performance as the set of initially unfamiliar items become familiar. The main question of interest here is whether, and when, self-priming effects emerge for the newly learned items. Depending on whether a within-domain or cross-domain task is employed, I take the magnitude of any self-priming effect to be either a valid indicator of both perceptual and semantic familiarisation or just of semantic familiarisation, respectively. A secondary interest is the development of perceptual representations / processing of the newly learned items (the indicator here is the general speed and accuracy to these items on each day of testing). The main yardstick used to measure the development of perceptual and semantic representations for the newly learned characters is the comparison of processing of such characters, at each stage of learning, with that for a set of well-known famous people. If comparable effects emerge for the newly learned items, are they of the same magnitude as for the famous items? What are the determinants of the change, if there is any change, in both perceptual and semantic processing of the newly learned items? These are the questions I intend to pursue.

4.2.1 Self-Priming in person recognition

4.2.1.1 Review of self-priming phenomena and explanations

Self-priming in person recognition is a well-established phenomenon (see Calder & Young, 1996; Calder, Young, Benson & Perrett, 1996; Young, Flude, Hellawell & Ellis, 1994; De Haan, Bauer, & Greve, 1992).[57] Self-priming is a form of the general associative context effect. In general, responses to judge the familiarity of Tony Blair's face (the target) will be faster if his face is preceded by the name of Cherie Blair (the prime) compared with being preceded by the name of Hugh Grant (related and unrelated conditions respectively). This is the general associative context effect in person recognition (Bruce & Valentine, 1986). It applies equally within and across stimulus domains, since similar amounts of priming are produced from either face-primes or name-primes to either face-targets or name-targets (Bruce & Valentine, 1986; Young, Helawell & De Haan, 1988; Calder & Young, 1996).

What differentiates self-priming from the more generic associative context effect is that in the related condition of a self-priming experiment, both the prime and the target are referents of the same identity. There is no such requirement for the general associative context effect. Thus responses to make familiarity decisions to the name of Tony Blair (the target) would be faster when preceded by Tony Blair's face (the prime) compared to being preceded by Bruce Willis' face. This is the basic effect of self-priming. This, furthermore, is an example of cross-domain self-priming (CDSP) as both the prime and the target here come from different stimulus domains (i.e. faces and names). Within-domain self-priming (WDSP), in contrast, is where one would view either faces or names as *both* prime and target (for instance, one might view an

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[57] See also Ellis, Jones & Mosdell (1998) for interesting evidence of self-priming from face or voice primes to face or voice targets on familiarity decisions with famous people.

image of Tony Blair's face at prime followed by a visually dissimilar second image of Tony Blair's face as the target, in the related condition). Self-priming is observed with an ISI (Inter Stimulus Interval) of around 250 ms between the prime and the target (Calder & Young, 1996). We should note that in within-domain self-priming the images of the two faces (the prime and target) are carefully chosen to be visually dissimilar, in order to reduce any effects of image repetition (and similarly for the name prime and name target which would be presented in different fonts).

Calder & Young (1996) studied the properties of self-priming in several experiments. They found significant self-priming of famous people from face or name primes to face or name targets on familiarity decisions. Further, the authors showed that within-domain self-priming produced significantly higher levels of priming than cross-domain self-priming although if the target stimuli are repeated often, this advantage of within-domain self-priming disappears. Finally, they found that self-priming produces more facilitation than does associative priming. We should note, as Calder & Young do, that these were all predictions derived from the Burton, Bruce and Johnson (1990) Interactive Activation and Competition (IAC) model and that all were corroborated. Thus the model stood up rather well to this series of tests.

In order to discuss the IAC explanation of these findings we must first digress to present an overview of the IAC model of familiar face recognition (see Burton et al., 1990). Recall from chapter one that the model consists of several pools of interacting units (Chapter 1, Figure 2, p11). Units relevant to a given person are connected between pools with excitatory bi-directional links, and units are connected within pools by inhibitory bi-directional links. If two units across pools are active at the same time then the link between them is strengthened using a Hebbian update rule. The FRU (Face Recognition Unit) pool contains recognition units for faces (there is a similar pool for names). On presentation of a familiar face, the relevant FRU is activated and this passes activation to the relevant PIN (located in the second pool of units – the Person Identity Nodes). There is a unique FRU and PIN for each person we know. The PIN then activates the relevant SIUs (Semantic Information Units, which comprise the third pool, such as "actor", "British"; these are shared units). Once activated, due to the bi-directional links, the SIUs pass activation back to PINs of people who share the same

SIUs as the presented face. Familiarity decisions, it is proposed, are taken at the level of the PINs (when a given PIN's activation passes some set threshold familiarity is signalled).

The IAC account of general associative context effects is the following: on viewing an image of Tony Blair's face, his FRU will *fire*. This in turn, will cause his PIN to *fire*. Due to PIN activation, the SIUs linked to Tony Blair will next become activated. Now, due to the bi-directional between-pool links, the activated SIUs will send activation *back* to the PINs to which they are linked. Thus the PINs of individuals who share semantic information with the prime will become activated somewhat (to different degrees dependent on how much semantic information they share with the prime). Thus if one then presents an image of, say, Cherie Blair, for a familiarity decision, her PIN will already be above resting level activation due the previous presentation of Tony Blair (since she shares much semantic information with him), and priming will be observed relative to the case where, say, Hugh Grant's face is presented. This is the IAC model's account of the general associative context effect.

Thus cross-domain self-priming (from a face prime to a name target) would be explained on the following basis: on viewing the face at prime the FRU-PIN-SIUs sequence for the relevant individual will be activated. Some SIU activation will feedback to the PINs. Specifically the PINs of those individuals who share semantic information with the prime will possess above resting level activation. The PIN, moreover, with the greatest above resting level activation will be that of the prime (since a person shares the maximal amount of semantics with herself) and thus on subsequent presentation of the same person's name as the target, facilitation will be observed relative to presentation of an unrelated target (due to the PIN reaching the threshold for signalling familiarity faster).

Thus cross-domain self-priming from a face-prime to a name-target would be explained as being due to the fact that when the target name (or face) is presented, the PIN of the relevant person is above resting-level activation due to the prior presentation of the same person's face (or name) at prime. This results in facilitation relevant to the case where an unrelated face is presented at prime (as two unrelated people would not share many SIUs so the PIN of the target would not be much above resting level activation when the target is presented). Within-domain self-priming has an additional mechanism to the one described previously (SIU-PIN links), which allows it to achieve a greater degree of priming. The same link is traversed both times when the prime and target stimuli are both of the same domain (the FRU-PIN link or NRU-PIN link), thus link strengthening occurs in this case but not for the cross-domain case as different recognition unit – PIN links are used here for the prime and target. This advantage, for the within domain case, can, however, be eliminated by repeated presentation of the relevant faces or names since the input unit-PIN links will reach asymptote. Once the input unit-PIN links reach asymptote only the PIN-SIU mechanism will then be able to contribute to the priming effect. The model also accounts for the fact that self-priming produces greater facilitation than associative priming as maximal PIN activation of person X (in terms of SIU feedback from previous presentation of a prime) will result from prior presentation of person X and not an associated person, as an associated person only shares some qualities with the target, whereas the target itself shares the maximal possible number of qualities with itself. We should, however, note that other types of explanations could also account for these results (see e.g. Hintzman, 1986; 1988; Anderson, 1990) though the effects certainly have not been derived from these models as they have been from the IAC model.

The IAC model predicts that self-priming should be found for familiar faces. This model, however, is only concerned with familiar face recognition and thus it does not account for unfamiliar face processing. The model does suggest though, by its mechanism of accounting for self-priming of familiar faces, that self-priming would not be found for unfamiliar faces, since the explanation for this phenomenon is either in terms of PIN-SIU links (for cross domain self-priming) or in terms of the former plus additional Recognition Unit-PIN links (within domain self-priming), neither of which we presumably have for unfamiliar faces. Of course, the basic point is that we have no semantic knowledge of unfamiliar items and we need this knowledge for the standard associative context effects to arise. Thus the IAC model would predict that neither within-domain or cross-domain self-priming would be observed for unfamiliar faces. I note that using a within-domain task would allow for a more general enquiry into the development of both perceptual and semantic knowledge as it is conjectured to be due to both a perceptual and a semantic mechanism whereas the use of a cross-domain task allows for a more detailed study of the development of semantic knowledge to the relative exclusion of perceptual knowledge (since only the semantic mechanism is thought to be responsible for priming here). It is still possible, however, to comment on perceptual processing when utilising a cross-domain task just not of perceptual mechanisms being responsible for any self-priming (if we adhere to the IAC model). I now attempt to justify both the use of an associative priming task in general and, in particular, the use of a self-priming task, as a tool to investigate familiarisation.

4.2.1.2 Use of Priming Task

The main advantage in using a self-priming task (or most associative priming tasks) here is that such a task is relatively implicit. It seems to be desirable to use a relatively implicit task to lessen the chance of participants' being aware of what it is that I want to study here (as opposed to say, asking questions at different stages throughout learning). Moreover, the more implicit the task the more it should reveal the underlying structure of knowledge rather than just task generated effects.

4.2.1.3 Use of Self-Priming

There are several advantages to the use of a self-priming task rather than a more generic associative priming task. The determining reason was pragmatic: it was not possible to find enough suitable related pairs of items from within the soap opera for use in an associative priming task. A self-priming task does not require pairs of related items. There are two other nice features of using self-priming as opposed to the more generic associative priming. First, since self-priming gives the maximal amount of associative priming possible, by using this type of priming I am maximising the chance of finding any associative priming effect for the newly learned items. Second, the two types of self-priming, the cross-domain and the within-domain variants, are conjectured to make different use of semantic and perceptual mechanisms to generate the priming effect. Thus by altering the variant one can alter the use of perceptual and semantic mechanisms in driving the effect. One cannot do this for generic associative priming.

4.2.1.4 Self-Priming as a tool to investigate the perceptual and semantic familiarisation of new people

From both the reviews of the IAC explanation of self-priming and the image-specific nature of unfamiliar face processing in other tasks (e.g. recognition; see chapter 1 section 1.3.1.2, p. 34) it is clear that either type of self-priming should not be observed for unfamiliar faces. Both forms of self-priming should, on the other hand, be observed for familiar faces. Thus self-priming seems to be a relatively implicit task that I can use to probe the processes of perceptual and semantic familiarisation of new people. The main question, to reiterate, is whether, and when, self-priming effects emerge for the newly learned items. The indicator of this is the magnitude of the self-priming effect, specifically whether it is significant or not, and further, how it compares to the magnitude observed for the control set of famous items. I will also comment on the development of perceptual processing for the newly learned items (the indicator here is the general speed and accuracy of response to the newly learned items) and speculate on the likely determinants of both semantic and perceptual developments. I am thus attempting to track the development of self-priming for the set of newly learned items. I initially chose to use a within-domain task (Experiment 4A) due to the fact that the soap opera materials are Irish and as such the names of the characters are not always easy to make out, which could have been problematical had we used the cross-domain form of self-priming. I circumvent this problem in a further experiment (Experiment 4B).

4.3 Experiment 4A – Semantic Familiarisation of Initially Unfamiliar People: (1) Within-Domain Self-Priming

In the following experiment participants watch several episodes of a previously unfamiliar soap opera over four days and perform a familiarity-decision task on days 2, 3 and 4. I include, in each experimental test, a set of famous items for comparison with the familiarised items. The main interest is in the magnitude of self-priming for the familiarised items, specifically whether it is significant or not, and further how it compares to that for the famous items, as indicators of the participants' state of familiarisation with the characters. During viewing of the episodes participants will be both *perceptually* and *semantically* familiarised to the characters of the soap opera. Thus I would expect self-priming to occur for the familiarised faces at some point during the three testing stages and for the famous faces at all three testing stages. In addition, according to the IAC model, both perceptual and knowledge-based mechanisms could be responsible for self-priming, if it is found, in this experiment.

4.3.1 Method

Participants

A total of 16 undergraduate and postgraduate students participated in this experiment. All were native speakers of British English and initially unfamiliar with the soap opera materials.[58]

Apparatus

The experiment was run on an Apple Macintosh G4 using the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993).

Design & Procedure

Participants viewed eight episodes of an initially unfamiliar soap opera ("Fair City") over four consecutive days, viewing two episodes a day for each day in turn (each episode lasts approximately 20 mins). On days 2, 3 and 4, participants performed a familiarity decision task. The primary interest in the present experiment, as previously stated, is in the amount of self-priming observed for both the famous and the familiarised items across the three days of testing on the familiarity task. Importantly, the definition of familiarity here employed was that for a face to be considered *familiar* the given face had to be recognisable (known) from out-with performing the familiarity decision task itself (and thus a famous face, a face from the soap opera or from the University would be here considered as familiar, whereas an unfamiliar face simply

[58] One participant had heard ofthe soap operathough had never watched it.

repeated twice in the familiarity task would not be). This definition allowed for repetition of the unfamiliar faces across blocks.

Three factors were investigated in the present experiment: Prime Type (self-prime or unrelated prime; repeated measure), Person Type (famous or familiarised; repeated measure) and Day (first, second or third day of testing; repeated measure). Examples of the two levels of Prime Type are shown below for famous people, the same format was used for the familiarised people and across the different days of testing.

Self-Prime: A familiar prime face and the familiar target face would both be referents of the same identity (for instance, Tony Blair's face followed by a visibly different image of Tony Blair's face).

Unrelated Prime: A familiar prime face would be followed by an unrelated familiar person's face (for instance, Tony Blair's face followed by Bruce Willis' face).

On each day, two blocks of 64 trials were presented to participants. On all trials participants were presented with familiar or unfamiliar target faces preceded by familiar prime faces. Each block consisted of 32 familiar target trials and 32 unfamiliar target trials. Within each block the familiar trials comprised 16 familiarised and 16 famous trials. Equal numbers (8) of familiarised and famous trials were preceded by self-primes and unrelated primes. For the unfamiliar trials in each block, the same primes that were used for the familiar trials in the given block were repeated as primes to unfamiliar target faces (32 different unfamiliar faces were used). Thus the familiarity of the prime was not a valid cue to the familiarity of the target.

From an initial pool of 16 well-known famous faces and 16 familiarised faces (the relevant statistics for the on-screen duration of the selected soap opera characters over the selected episodes are: maximum = 35 mins; minimum = 7.4 mins; mean = 18.6 mins, $s =$ 7.95 mins.), two sets of eight famous faces and two sets of eight familiarised faces were created by random selection (giving set A famous and set B famous and set

A familiarised and set B familiarised). Each set of faces consisted of 16 images (that is, two *visibly different* images of each person, one for the prime and one for the target). In block 1, the set A prime faces acted as primes in the self-prime and unrelated conditions and further twice as primes to the unfamiliar faces in this block (each time with a different unfamiliar target face). The set A target faces were used as the targets in the self-prime condition whereas the set B target faces were used as the targets in the unrelated condition. This procedure was the same for both the familiarised faces and the famous faces. Unfamiliar trials consisted of the exact same primes as for the familiar trials being followed by unfamiliar target faces.

In block two the same procedure was followed except that the prime images came from the alternative set than that which was utilised in block one. Thus set B prime faces were used as self-primes, unrelated primes and twice as primes to unfamiliar targets (each time with a different target) in this block. Further the set B target faces were used as targets in the self-prime condition whereas the set A target faces were used as the target faces in the unrelated condition here. Note that the unfamiliar targets are repeated across blocks.[59] There were, therefore, 128 trials across blocks with 64 in each. Trials within each block were presented in a random manner.

On each trial a fixation cross first appeared for 250 ms. This was followed by a prime face for 250 ms, then an ISI for 250 ms, and then the target face which was on-screen until a response. A delay was then interposed between each trial of 500 ms. Gray-scale face images were presented in an on-screen frame of approximately 5.6 cm by 5.6 cm. Participants were asked to attend to the prime face and to make a familiarity decision to the target face ("Is this face familiar or unfamiliar to you?", see the design section for the precise definition of familiarity used in this experiment) as quickly and as accurately as possible. They were instructed to press the 'A' key for "Unfamiliar" and the 'L' key for "Familiar". Experimental trials were preceded by 8 practice trials in the same format so as to orient participants with the general task procedure. Participants were instructed to have a short break between blocks if required.

[59] This was done simply for expediency and not for any experimental purpose; I am not interested in responses to unfamiliar faces in this experiment and as such they are only here to create the task demands for the experiment.

Participants performed the same task over the three days of testing after viewing four, six and eight episodes, respectively, of the soap opera. The only variable which changed across the days of testing was the order in which the blocks were presented to participants. Thus block order was counterbalanced across participants on each day of testing and within participants across the different days of testing. The *same* face images were presented each day since finding 6 *visibly different* famous face images for each famous person and 6 *visibly different* familiarised face images for each character was not possible given material and time constraints.

4.3.2 Results

Both the response latency data and the accuracy data were each initially subjected to a three-way ANOVA with the following factors: Prime Type (self-prime or unrelated prime), Person Type (famous or familiarised) and Day (1, 2, or 3). All factors were repeated measures. The means pertinent to this analysis are displayed in Table 10 (next page).

Response Latency

This analysis revealed a reliable main effect of Prime Type, $F\ (1, 15) = 16.86, p = 0.001$, thus responses were made faster in the self-prime (M = 641 ms) than the unrelated condition (M = 693 ms). Significant main effects of Person Type and *Day[60] were also found (both F's > 17.0, both p's < 0.01), though these effects were modified by the presence of a significant interaction between these two factors, *$F\ (1.54, 23.15) = 6.99, p = 0.007$. To further investigate this interaction, separate one-way repeated measures ANOVAs were computed for Person Type at each level of Day in turn.[61] These tests showed that the effect of Person Type was significant on each day in turn, though the effect was notably larger on day 1 than on latter days. For all three days, however, the pattern was that of quicker responding to the famous faces than the familiarised (newly learned) faces (M_{FD1} = 704 ms; M_{NL1}= 827 ms; M_{FD2} = 609 ms;

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[60] The placement of a * before any main effect or interaction (either the name or the statistics) indicates that the sphericity assumption of univariate repeated measures ANOVA did not hold for this effect and in each of these cases the Huynh-Feldt correction was applied (hence the degrees of freedom are no longer exact for such effects).

[61] See Howell (1997), p468; this is due to the problematical nature of using analyses of Simple Main Effects (SMEs) when the sphericity assumption of univariate repeated measures ANOVA is violated.

M_{NL2}= 677 ms; M_{FD3} = 569 ms; M_{NL3}= 613 ms). Thus the interaction arises here since the effect of Person Type is larger on day 1 than on the latter days. For both the famous and the familiarised faces, responses speed-up considerably across the three days of repeating the task, demonstrated by significant main effects of Day in separate one-way repeated measures ANOVAs for each level of Person Type.

Table 10: Mean of median response latency (ms), one standard error (in parentheses), and mean percentage correct [in square brackets] as a function of Prime Type, Person Type and Day, for Experiment 4A. Relevant data are also displayed for unfamiliar target trials. The table also displays the amount of priming (ms) for each Person Type on each Day.

	Self-Prime	*UnR-Prime*	*Amount of Priming^*	*Unfamiliar*
Day 1				
Famous	**684** (23) [96.1]	**725** (24) [95.7]	41	**808** (34) [94.9]
Familiarised	**819** (64) [83.6]	**835** (32) [76.6]	16	**844** (43) [94.3]
Day 2				
Famous	**574** (16) [97.3]	**644** (15) [96.9]	70	**696** (33) [96.3]
Familiarised	**639** (34) [94.1]	**715** (30) [92.6]	76	**725** (44) [96.9]
Day 3				
Famous	**540** (29) [98.4]	**598** (21) [95.7]	58	**650** (35) [95.1]
Familiarised	**587** (16) [97.3]	**638** (20) [93.8]	51	**647** (31) [96.5]

^ Amount of Priming = UnR-Prime – Self-Prime.

Unfamiliar target trials consist of an unfamiliar target proceeded by either a famous or a familiarised prime. Familiar target trials (self-prime and unrelated prime trials) always consist of a prime and target of the same person type.

Furthermore, the interaction between Prime Type and Day was marginally non-significant, *p = 0.074. This suggestion of an interaction seems to arise since the effect of Prime Type (when collapsed across the famous and familiarised conditions) is very small on day 1 compared to the later days of testing (M_{D1SP} = 752 ms; M_{D1U}= 780 ms; M_{D2SP} = 607 ms; M_{D2U}= 680 ms; M_{D3SP} = 564 ms; M_{D3U}= 618 ms). No other effects approached significance.

Response Accuracy

Turning now to the consideration of the accuracy data from the present experiment, the main effects of all three factors were significant (all *F's* > 19.0, all *p's* < 0.001). Two second order interactions were also significant, that between Person Type and Day, $*F\,(1.66, 24.83) = 21.3, p = 0.00001$, and that between Person Type and Prime Type, $F\,(1, 15) = 4.64, p = 0.048$.

To further investigate the Person Type by Day interaction separate one-way ANOVAs were carried out for Person Type at each level of Day in turn. The effect of Person Type was significant for day 1, marginally non-significant for day 2 ($p = 0.053$) and non-significant for day 3 ($M_{FD1} = 95.9\%$; $M_{NL1} = 80.1\%$; $M_{FD2} = 97.1\%$; $M_{NL2} = 93.4\%$; $M_{FD3} = 97.1\%$; $M_{NL3} = 95.5\%$). Thus differences between the famous and the familiarised faces are clearly present on day 1, and almost there on day 2, but disappear completely by day 3. Thus by day 3, in terms of accuracy, we can detect no reliable difference between responding to the famous and the familiarised faces. By day 3 then, considerable learning of the familiarised faces has occurred and as such the effect of Day is present for the familiarised faces, although not for the famous faces (verified by performing separate one-way repeated measures ANOVAs for Day at each level of Person Type).

Further analysis (SMEs) of the Person Type by Prime Type interaction shows that it arises due to the fact that the effect of Prime Type is significant only for the familiarised faces and not for the famous faces (though the means are in the correct direction for the famous faces, the actual difference is extremely small) [$M_{NLSP} = 91.7$; $M_{NLU} = 87.6$; $M_{FSP} = 97.3$; $M_{FU} = 96.1$]. For the famous faces, performance is close to ceiling, thus perhaps masking any difference between the self-prime and unrelated conditions here. For the familiarised faces, however, this effect of Prime Type is clearly present, with responses in the self-prime condition being more accurate than those in the unrelated condition. Moreover, the effect of Person Type is present for both the self-prime and the unrelated conditions, with famous faces being responded too more accurately than familiarised faces in both these conditions.

The three-way interaction between all the factors was marginally non-significant ($p = 0.075$). The suggestion of an interaction here is most likely due to the fact that the form of the Person Type by Prime Type interaction changes across the different days of the experiment. This two-way interaction seems to be present strongly on day 1 and, although much weaker, the same shape is still present on day 2, but there are parallel lines on day 3.

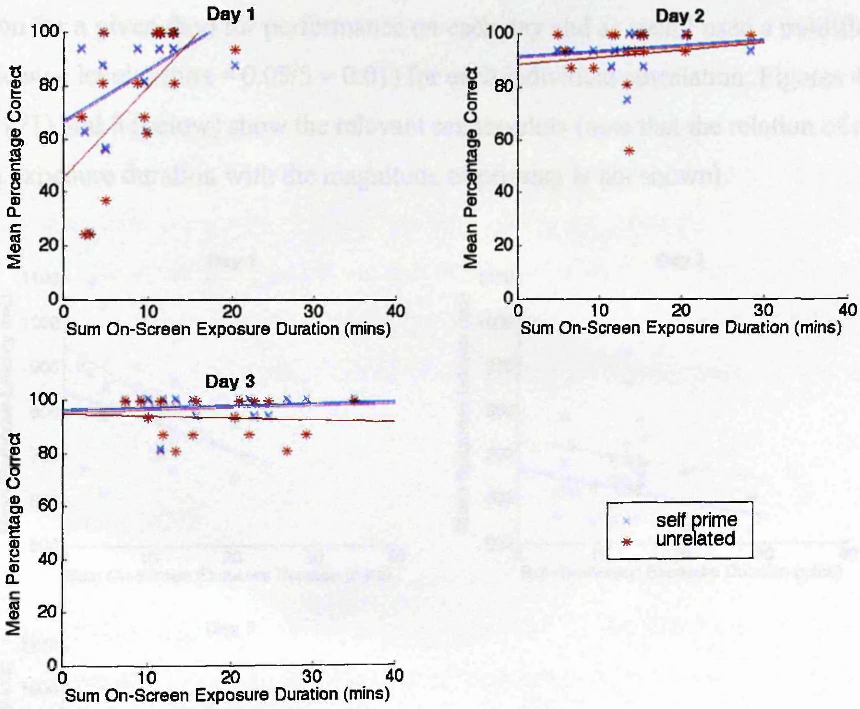

Figure 4: Mean percentage correct for the newly learned faces in both the self-prime and the unrelated condition on each day as a function of on-screen exposure duration (mins) for Experiment 4A [N = 16 in each case].

On a different tack, it is interesting to investigate whether performance for each newly learned item can be predicted, at the appropriate stage of testing, by the on-screen exposure duration for that item at that point of learning.[62] Pearson's correlations

[62] These numbers were computed by Zoe Henderson.

were computed in the following manner: the summed on-screen exposure duration (in minutes) for each character at the appropriate stage of learning was correlated independently with the mean percentage correct and the mean response latency for that character as a target item in both the related and unrelated conditions respectively. I also correlated on-screen exposure duration with the magnitude of priming observed for a given character (defined as unrelated median minus related median for each character as a target). This led to five correlations using the same variable (on-screen exposure duration for a given day) for performance on each day and as such I used a modified significance level (alpha = 0.05/5 = 0.01) for each individual correlation. Figures 4 (page 171) and 5 (below) show the relevant scatter-plots (note that the relation of on-screen exposure duration with the magnitude of priming is not shown).

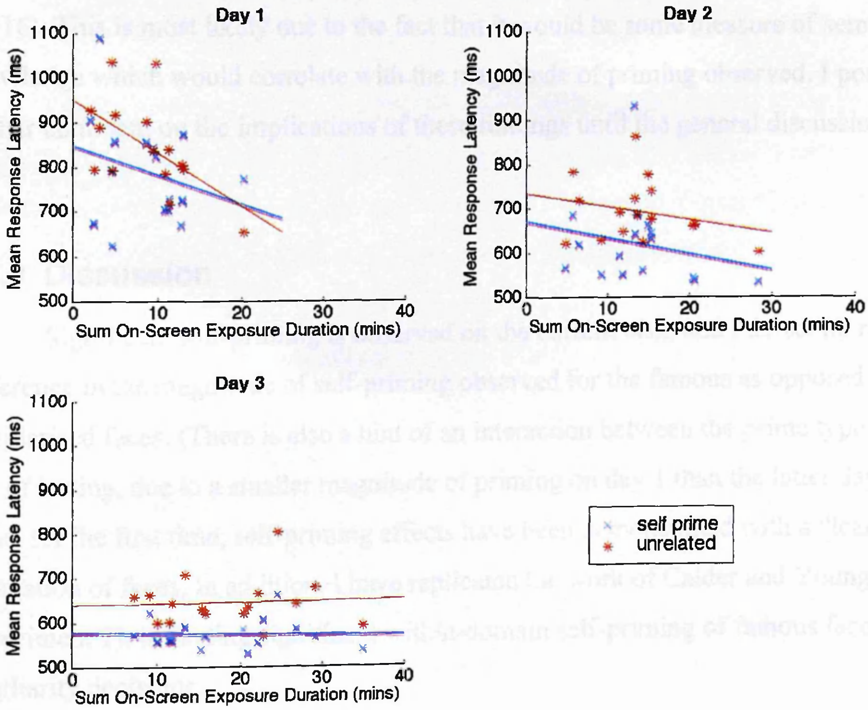

Figure 5: Mean response latency for the newly learned items in both the self-prime and the unrelated condition on each day as a function of on-screen exposure duration (mins) for Experiment 4A [N = 16 in each case].

Considering performance on the first day of testing, the correlation between on-screen exposure duration and percentage correct in the unrelated condition was significant (r = 0.63, $p = 0.0089$, N = 16). Further, the correlation between on-screen exposure duration and mean response latency in the unrelated condition was marginally non-significant (r = -0.58, $p = 0.0192$, N = 16). On-screen exposure duration, in contrast, did not correlate well with either percentage correct in the related condition ($p = 0.0801$) or mean response latency in the related condition ($p = 0.2937$). Thus on-screen exposure duration seems like it might be a reasonably good predictor of performance in the unrelated condition here yet not of performance in the related condition. Why is this so? Perhaps the reason is that a semantic variable would correlate disproportionately with performance in the related condition. None of the above relations, moreover, were significant on the latter two days of testing (for all $|r| < 0.25$, $p > 0.34$, N =16). The magnitude of priming, furthermore, did not correlate significantly with on-screen exposure duration at any stage (for all $|r| < 0.22$, $p > 0.41$, N =16). This is most likely due to the fact that it would be some measure of semantic knowledge which would correlate with the magnitude of priming observed. I postpone further comment on the implications of these findings until the general discussion.

4.3.3 Discussion

Significant self-priming is observed on the current task, and I detect no reliable difference in the magnitude of self-priming observed for the famous as opposed to the familiarised faces. (There is also a hint of an interaction between the prime type and the day of testing, due to a smaller magnitude of priming on day 1 than the latter days.) Thus, for the first time, self-priming effects have been demonstrated with a "learned" population of faces. In addition, I have replicated the work of Calder and Young (1996; Experiment 2), in finding significant within-domain self-priming of famous faces onto familiarity decisions.

Visual inspection of the means does, however, suggest a trend towards a greater amount of priming for the famous faces than the familiarised faces on day 1, although this is not present on the latter days. This is the pattern one would expect since on day 1 the famous faces are already well endowed with knowledge whereas the familiarised faces are only beginning to be so endowed. Furthermore, responses are made significantly faster to famous faces on all three days than to familiarised faces, though the magnitude of the difference decreases across the three days. Responses, in addition, are made more accurately to famous faces on day 1 and day 2 (marginally non-significant here) but accuracy is non-significantly different across the famous and familiarised faces by day 3. Thus on both response latency and response accuracy, significant learning is occurring for the familiarised faces, due presumably, to participants' perceptual and semantic learning of the characters from the soap opera across time.

The learning period which participants engage in, in this study, has, therefore, proved rich enough to stimulate the formation of strong perceptual and semantic representations for the main characters from the soap opera (over the four days of learning). Thus the methodology appears to hold promise for future work of a finer resolution.

I note, however, that the magnitudes of the self-priming effects in the present study are considerably less than previously reported. I will only consider here the differences as they apply to the famous faces since Calder and Young (1996) used famous faces in their study (and thus I can directly compare) and also since the reason why the effects are small for the familiarised faces may just be due to the learning period employed here. In comparison with the relevant experiment of Calder and Young (1996; Experiment 2), the magnitude of priming here has an average of 54 ms for the famous faces (averaged across the three days of testing) whereas these authors reported a priming effect of 184 ms. This is clearly a rather large difference and one that requires explanation. The priming effect which I report is less than one-third of the priming effect which Calder and Young (1996) report.

There are several potential reasons for the discrepancy. First, the average visual dissimilarity between the prime face and the target face in the self-prime condition may have differed across the two studies. Indeed, in their study, Calder and Young attempted to use two different but current images of the relevant famous person (A.

Calder, personal communication). In the present study, the average visual dissimilarity between the prime and the target faces may have been greater as I made the conscious attempt to have the two images of the famous person be considerably different, in order to reduce the visual similarity between the prime and the target as much as possible (to force use of semantic knowledge). As such, for several famous people, the two images for the one famous person spanned quite a wide temporal lag. Furthermore, for at least six famous people, the two images differed considerably in external features (primarily the hair). If the two images had been *current* then one would expect that, more often than not, the hairstyle would have been similar. Thus for around 8 out of the 16 famous people selected for use in the present study, the two images were notably different. Now, presumably either A) if participants do not recognise the prime face or the target face, priming for that given item will tend to be minimised or B) if recognition of the prime face takes longer than it would otherwise, the priming effect would be decreased, by reducing the amount of time in which the prime has to *activate* the target. Thus there are two mechanisms which could, plausibly, have contributed to a reduction in the amount of priming in this study. Unfortunately no other research has been performed relevant to this discussion in which the degree of visual dissimilarity between the prime face and the target face has been systematically varied.

Even if, however, visual dissimilarity was an important factor in explaining the difference in the magnitude of priming across the two studies, it seems unlikely that it is responsible for all of the difference (130 ms). Indeed it would seem to be most important on day 1, and perhaps accounts, in part, for the very low magnitude of priming on this day (41 ms). With practice, however, most participants probably come to recognise the images (i.e. by day 2 and 3). There is one other important disparity, however, between the two studies which could be responsible for much of the difference in the reported magnitudes (and applies equally across each day of the experiment). This second factor represents a difference in design between the two studies. To describe this difference of design we have to consider what happens in each block for each experiment. For the present experiment, two sets of famous faces are created by random selection, and one of these sets acts as both the primes and targets in the self-prime condition, as primes in the unrelated condition and twice as the primes to unfamiliar targets in block one. The second set act only as the unrelated targets in block one. In block two the mapping of sets to conditions simply reverses. Thus in the present experiment, within each block, there is a ratio of 5:1 of the presentation of identities from one set to the other. In the limit, after the two blocks, this of course averages out.

Comparing this with the design of Calder and Young (1996; Experiment 2), within each block in their study there is no imbalance as that above. Calder and Young use different sets of faces for primes and targets in each condition within any block, save for the self-prime condition. Thus the only *imbalance* is that of viewing the identities in the self-prime condition twice (as both primes and targets in this condition), which is necessary, as this is the manipulation required to investigate self-priming. So in Calder & Young, in any block, one only views two presentations of the famous identities in the self-prime condition. This is not the case, however, for the present experiment where participants view the identities of the famous people in the self-prime condition *five times* across the block, compared with only one presentation of the items in the unrelated condition.

Now, the main implication this difference of design has for explaining the discrepancy in the magnitudes of priming reported in each study is the following: the magnitude of self-priming in the current experiment will be *reduced*, compared to that found by Calder and Young in their Experiment 2, since here the prime faces in any one block have been repeated five times within that block, which will cause the FRU-PIN links to approach asymptote and thus *reduce* the magnitude of self-priming to nearer the levels normally seen for the cross-domain form of self-priming (with the only fully "working" mechanism being the PIN-SIU links). This will be the same for both blocks of the current experiment on each day (indeed any effect would likely be greater on the latter days due to the previous experience). There is one other factor, however, which might mitigate any decrease in the magnitude of self-priming due to repetition of the items. This would have potentially a large effect in the first block of trials but not in the second block. In the first block of trials participants will presumably be processing the repeated items faster than the non-repeated items (the targets in the unrelated condition) and as such responding to the targets in the unrelated condition will take longer than if they had been repeated within the first block of trials (taking all else constant). (Calder and Young, in contrast, had no such differential repetition within their comparable experiment.) This should increase any priming effect in this block relative to the second block of trials. There is a small difference between the magnitude of priming observed for each block of trials on day 1 for the famous items, but with 10 ms greater priming for the second block of trials. Thus the differential repetition does not seem to increase the priming effect for block one. (Of course there are other factors which change between blocks which could interact with any such effect of differential repetition but the effect is clearly not dominant.)

In their Experiment 3, Calder and Young tested whether repeated presentation of their name targets would reduce the WDSP effect to the levels normally seen for CDSP, and they found exactly that. Half of their participants performed a within-domain self-priming task (name primes to name targets) with a total of nine repetitions of the target names by the end of the task. The other half, in contrast, performed a cross-domain self-priming task (face primes to name targets) prior to the within-domain self-priming task, which would have led these participants to experience a total of 13 repetitions of target names by the end of the within-domain task.[63] Thus taking a simple average across these two groups of participants there would have been 11 repetitions of target names for Calder and Young's experiment (the authors do not distinguish between the two groups of participants in their analyses). Their average magnitude of self-priming in the WDSP repeated condition was 82 ms compared to 151 ms for non-repeated WDSP of names in their Experiment 1.

Thus, there is clearly a substantial decrease in the magnitude of WDSP when the stimuli are repeated, and this factor, I conjecture, accounts for most of the difference between the magnitude of priming found in the current study and in Calder and Young's Experiment 2. I note that the number of repetitions was certainly less in the present experiment than in Calder and Young (6, within one day of testing here, to 11). It may well be the case, however, that five, relatively immediate, repetitions are sufficient to cause the recognition unit-PIN links to approach asymptote, despite any effects of differential repetition of the unrelated targets in block one. The effect of item

[63] Calder & Young (1996) do not state exactly how many repetitions there were, however, I have inferred these numbers from the structure of their design.

repetition, I propose, acts in concert with visual dissimilarity on day 1 to reduce the magnitude of priming to a very small level, but on day 2 visual dissimilarity does not have as large an effect and similarly on day 3. Yet the effect of item repetition may well be growing over the three days of testing. This influence of the design anomaly, now that it has been identified, will be removed from any future experiments.

One other possible reason, in addition, for the low magnitude of priming present on day 1 for the famous items is the familiarity of the famous items themselves. This was not assessed prior to the experiment, or post-experiment, rather I assumed that these famous people would be well known on average. Thus it would certainly be beneficial for any future experiments in this line to employ a pre-experiment orientation phase where participants would be shown each famous person's face images for a simple familiarity response. This should work to minimise any difficulties in recognition of the images for the first time in the main experiment. Thus this approach has the potential to mitigate considerably the role of visual dissimilarity in reducing the magnitude of priming present for the famous items on day 1. Given, however, the low magnitudes of self-priming observed even on days 2 and 3 for the famous people (when the images should be recognised better) famous person familiarity would not seem to be the main factor responsible for the small magnitude of priming observed overall.

4.4 Experiment 4B – Semantic Familiarisation of Initially Unfamiliar People: (2) Cross-Domain Self-Priming

In the following experiment I investigate the perceptual and semantic familiarisation of the soap opera characters using a design that differs to Experiment 4A in several respects. First, I use a different form of the self-priming paradigm, cross-domain self-priming (from name primes to face targets; see Calder & Young, 1996; Experiment 2) onto familiarity decisions, as the task to tap the processes of familiarisation. Thus this experiment is more focused in terms of studying the sole contribution of semantic familiarisation to the self-priming effect, since the only applicable mechanism here is the PIN-SIU links. Second, within each block the same items appear in the self-prime and the unrelated conditions thus removing any imbalance in the presentation frequency of items within each block (see design). Further, I note that when using a cross-domain task item repetition itself is not a problem as it is if using a within-domain task. Third, different face images are used each day (for both familiar and unfamiliar faces) to eradicate any benefit which might accrue due to processing the same image on each day. Fourth, in order to ensure that participants learn the full names of the characters from the soap opera (see earlier), participants were required to perform a simple task while watching each episode of the soap opera. This involved participants simply ticking off each main character's name on a cast list when that individual appeared in a particular episode (the full name was presented on the cast-list).

I expect reliable self-priming for the famous items on all three days of testing and, from Experiment 4A, for the familiarised items on at least days 2 and 3 (whether to expect such priming on day 1 is not clear from Experiment 4A). I now progress to describe the method for the current experiment. Within the method section, and prior to the results section of the current experiment, I describe a control experiment (Experiment 4Z) which serves as a check on the validity of the experimental materials used.

4.4.1 Method

Participants

A total of 18 undergraduate and postgraduate students participated in this experiment. All were native speakers of British English and initially unfamiliar with the soap opera materials.[64]

Apparatus

The experiment was run on an Apple Macintosh G4 using the PsyScope software (Cohen, MacWhinney, Flatt & Provost, 1993).

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[64] One participant recognised a non-critical member (i.e. not used in the experiment reported here) of the cast as being a renowned singer.

Design

Participants viewed eight episodes of an initially unfamiliar soap opera ("Fair City") over four consecutive days, viewing two episodes a day for each day in turn. On days 2, 3 and 4, participants performed a familiarity decision task. The primary interest in the present experiment is in the amount of self-priming observed for both the famous and the familiarised items across the three days of testing on the familiarity task. Importantly, the definition of familiarity here employed was the same as for Experiment 4A.

Three factors were investigated in the present experiment: Prime Type (self-prime or unrelated prime; repeated measure), Person Type (famous person or familiarised person; repeated measure) and Day (first, second or third day of testing; repeated measure). Examples of the two levels of Prime Type are shown below for famous people, the same format was used for the familiarised people and across the different days of testing.

Self-Prime: A familiar prime name and the familiar target face would both be referents of the same identity (for instance, Tony Blair's name followed by Tony Blair's face).

Unrelated Prime: A familiar prime name would be followed by an unrelated
familiar person's face (for instance, Tony Blair's name followed by Bruce Willis' face).

On each day, two blocks of 64 trials were presented to participants. On all trials participants were presented with familiar or unfamiliar target faces preceded by familiar prime names. Each block consisted of 32 familiar target trials and 32 unfamiliar target trials. Within each block the familiar trials comprised 16 familiarised and 16 famous trials. Equal numbers (8) of both familiarised and famous target faces were preceded by self-prime and unrelated name primes. For the unfamiliar trials in each block, the same primes that were used for the familiar trials in the given block were each used here as primes to unfamiliar target faces. Thus the familiarity of the prime was not a valid cue to the familiarity of the target.

Names and faces of 8 unrelated pairs of famous people and 8 pairs of unrelated soap opera characters (the relevant statistics for the on-screen duration of the selected soap opera characters over the selected episodes are: maximum = 35 mins; minimum = 8.9 mins; mean = 18.7 mins, s = 7.82 mins) were used as familiar stimuli in the present experiment.[65] Half of each set of pairs were randomly assigned to block 1 and half to block 2. For both the familiarised and famous stimuli, the names of the 4 pairs of items assigned to block 1 were used as self-primes, unrelated primes and further twice as primes to different unfamiliar targets in this block. The faces of the same 4 pairs of items assigned to block 1 were used as targets in both the self-prime and the unrelated condition.

To create the block 1 unfamiliar target trials the exact same familiar primes (8 famous, 8 familiarised) were followed by 16 unfamiliar target faces; each unfamiliar target face was repeated (with a different name prime from the same original set of 16) to give 32 unfamiliar target faces; thus ensuring equal repetition of the familiar and unfamiliar target faces within each block. Unfamiliar faces came from additional unfamiliar soap operas (both screen-caps and cast photos) and casting agency images. Presentation of each type of unfamiliar face was controlled to ensure equality of appearance after famous name primes and familiarised name primes within each block. Participants' knowledge of all the "unfamiliar" soap operas was checked prior to the commencement of the experiment and any who had viewed these programmes were replaced (as were any who were familiar with the actors in them).

[65] The famous people and soap opera characters used were the same as that in Experiment 1 save two changes. First, for the famous people, George W. Bush was replaced with Ronan Keating due to the fact that to unambiguously identify the current president of America a middle initial would have to be used (to dissociate the current president from his father) and this would then be different than for all the other familiar name primes in the present experiment. Second, one character of the soap opera ("Mags Kelly") was replaced with another character ("Charlie Kelly") as it was found that the replacement character appeared on-screen in the selected episodes for a longer duration.

The same procedure, for both the familiar and the unfamiliar trials, was followed in block two except that the other set of 4 pairs were used as the familiar stimuli (for both the familiarised and famous people) and a different set of unfamiliar faces (16) were used as the unfamiliar targets here. All participants were presented with both blocks on each day of testing. Trials within each block were presented in a random order.

Participants performed the same task over the three days of testing after viewing four, six and eight episodes, respectively, of the soap opera. For any given participant, prime names were presented in a different font each day and different images of the same familiar target faces were used each day, in order to eliminate any effects of image-specific repetition priming (see Roberts & Bruce, 1989). Each participant viewed different sets of unfamiliar faces each day (this was counterbalanced across participants so that each set of unfamiliar faces was viewed by different participants each day). The presentation of different fonts and of different images of familiar faces were counterbalanced across participants so that each different font and each different image were presented on each different day across participants. Thus font type, image of each familiar person, block order, and in addition, set of unfamiliar faces, were counterbalanced across participants within each day and within participants across days. This counterbalancing resulted in six versions of the familiarity task, where initial assignments of faces to block, faces to version and font type to version were random.

Procedure

Episode Viewing Task

Participants were required to perform a simple character occurrence task while viewing each episode of the soap opera. This entailed ticking off each main character's name on a cast list if the given character appeared in the episode which they were viewing. Only the critical characters appeared on the cast list (i.e. those who are used in the familiarity decision task; 16 plus 1 for practice trials). Each participant was presented with a different random order of the 17 full names, and the order remained constant for each participant across episodes. The point of this task, let us recall, was to ensure that participants learn the *full names* of the main characters from the soap opera which is critical for cross-domain self-priming (since the soap opera is of Irish origin and the names are not always easy to make out and further since *full names* of some characters are not necessarily clear from the episodes which participants view).

Familiarity Decision Task

On each trial a fixation cross first appeared for 250 ms. This was followed by a prime name for 250 ms, then an ISI of 250 ms, followed by the target face which was on-screen until a response. A delay was then interposed between each trial of 500 ms.[66] Names were presented in a clear font (Helvetica, Charcoal or Courier; all bold and all point size 30). Gray-scale face images were presented in an on-screen frame of approximately 6 cm by 4.5 cm (where the head filled the frame so far as possible). Participants were asked to attend to the prime and to make a familiarity decision to each target face (using the criterion of familiarity discussed above) as quickly and as accurately as possible. They were instructed to press the 'A' key for "Unfamiliar" and the 'L' key for "Familiar". Experimental trials were preceded by 8 practice trials in the same format so as to orient participants with the general task procedure. Participants were instructed to have a short break between blocks if required.

Prior to presenting the results of this experiment I report on a control experiment (Experiment 4Z) where a different set of participants performed the above familiarity decision task (each only once) without any experience of the soap opera. The aim was to demonstrate significant self-priming for the famous items in the absence of any priming for the to be familiarised items. This experiment serves as a control test of both the materials and the specific paradigm I chose to use for the second learning experiment. I chose to have a different set of participants perform this task, rather than have the learning set of participants perform the task prior to any viewing of the soap opera, since finding enough images may well have become a problem had we

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[66] We note that Calder & Young (1996) found in their comparable experiment (their Experiment 2) a suggestion of inhibition, though it was a non-significant trend and due mainly to three participants. Since the primes in this experiment are names and have to be read we did not shorten the SOA for the present experiment.

needed another day's worth of familiarised and famous images. The reason this experiment is performed in a cross-domain manner is that if one performed such an experiment in a within-domain manner I would expect some priming even for unfamiliar items (e.g. from one face image to a different face image of the same person; or the same name in two different fonts). For cross-domain priming to arise, however, the relationship between a person's name and their face has to be learned and this relationship will not have been learned for unfamiliar items.

We may expect, since there are more unfamiliar items, that the critical unfamiliar items will be processed somewhat faster than if the balance of familiar to unfamiliar was equal. This, however, would be constant across the self-prime and unrelated (familiarised) conditions and thus our comparison of interest is still valid (i.e. the amount of priming displayed for each set of items, famous and familiarised), assuming that amount of priming for a given set of items does not interact with how many targets of that type are processed in a task. We have no reason to expect that it does so interact.

4.4.1.1 Method for Experiment 4Z[67]

Participants

A total of 18 undergraduate students participated in this experiment (none of these participants took part in Experiment 4A or 4B). All were native speakers of British English and were initially unfamiliar with the soap opera materials.

Design and Procedure

Participants performed the familiarity decision task in the same manner to that detailed above except for the following details. In this experiment the familiarity decision task was performed by participants without any experience of the soap opera and further on only one occasion by each participant. Thus the to be familiarised items would here be unfamiliar to participants. Thus for these participants there is a ratio of

[67] The data for this experiment were collected by an undergraduate project group under the supervision of FWS.

1:3 of familiar to unfamiliar items in the familiarity decision task (whereas for participants who watch the soap opera this ratio gradually increases to the limit of 1:1). The consequence of this uneven ratio of familiar to unfamiliar items would presumably be that participants expect to view unfamiliar items with a higher probability than familiar items. This possibility invalidates the comparison which could be made between familiar and unfamiliar responses as a whole, since there are more of one type than another. However our interest here is simply in the amount of self-priming observed for the famous items and the to be familiarised items – and this comparison is not invalidated by the present concern.

4.4.1.2 Results for Experiment 4Z

Table 11 (next page) displays the relevant means and standard errors for correct responses to famous and to the to be familiarised target faces. A related samples t-test was used to compare the means for the two Prime Type conditions (self-prime, unrelated prime) independently for each Person Type (famous, to be familiarised). The analysis was performed in this manner since the correct response was different for each Person Type – familiar for the famous items and unfamiliar for the to be familiarised items. For the famous items, the difference between the self-prime and unrelated prime conditions is highly significant, $t\ (17) = 4.95, p < 0.001$. Thus response latencies to verify famous target faces as familiar are reliably faster when preceded by a self-prime name (M = 589 ms) rather than by an unrelated prime name (M = 772 ms).[68] Turning to the to be familiarised items, the t-test is here non-significant, $t\ (17) = -1.64, p = 0.12$. As expected, there was no significant difference between response latencies to reject the to be familiarised target faces as unfamiliar when these faces are preceded by self-primes versus unrelated primes.

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[68] I note that the magnitude of priming observed here seems very large, 183 ms, especially when compared with that for day 1 of Experiment 4B of the famous items (about 100 ms). Note, however, that this is the result of two outliers within the data set and that with these points removed the magnitude of priming drops to more normal levels, 136 ms. I left these points in the analysis since the pattern of significance is unchanged with or without them.

Table 11: Mean of median response latency (ms), one standard error (in parentheses), mean proportion correct [in square brackets] and amount of priming (ms) as a function of Prime Type and Person Type, for Experiment 4Z. Data for unfamiliar target trials are also displayed. The table also displays the amount of priming (ms) for each Person Type (with the standard error of the mean difference in parentheses).

Person Type	*Prime-Type*		*Amount of Priming^*	*Unfamiliar*
	Self-Prime	UnR-Prime		
Famous	**589** (20) [94.8]	**772** (47) [93.4]	183 (37)	**747** (70) [97.7]
Familiarised	**783** (107) [99.0]	**742** (93) [99.3]	- 41 (25)	**793** (97) [98.6]

^ Amount of Priming = UnR-Prime – Self-Prime.

Unfamiliar target trials consist of an unfamiliar target proceeded by either a famous or a familiarised prime. Familiar target trials (self-prime and unrelated prime trials) always consist of a prime and target of the same person type.

Thus we observe a clear self-priming advantage for the famous items and no self-priming for the to be familiarised items, which is as predicted. The self-priming advantage for the famous items replicates previous work on this topic (e.g. Calder & Young, 1996). Since the to be familiarised items are here unfamiliar we would not expect any priming effects to occur for these items (i.e. as participants have no knowledge to link the name and the face of the familiarised items). This experiment then demonstrates explicitly that knowledge is a prerequisite for cross-domain self-priming effects to occur. I now progress to report the results of the main experiment in which a novel set of participants gradually become familiarised with the familiarised items during learning.

Table 12: Mean of median response latency (ms), one standard error (in parentheses), and mean percentage correct [in square brackets] as a function of Prime Type, Person Type and Day, for Experiment 4B. Relevant data are also displayed for unfamiliar target trials. The table also displays the amount of priming (ms) for each Person Type on each Day.

	Self-Prime	*UnR-Prime*	*Amount of Priming^*	*Unfamiliar*
Day 1				
Famous	**600** (24) [97.2]	**699** (26) [96.9]	99	**846** (41) [92.4]
Familiarised	**727** (27) [80.6]	**770** (22) [82.3]	43	**838** (43) [92.0]
Day 2				
Famous	**542** (20) [98.2]	**640** (21) [96.9]	98	**699** (26) [95.3]
Familiarised	**620** (16) [91.7]	**682** (22) [91.3]	62	**679** (21) [94.6]
Day 3				
Famous	**541** (21) [98.2]	**590** (18) [93.8]	49	**651** (22) [97.6]
Familiarised	**573** (16) [96.5]	**620** (13) [95.5]	47	**649** (19) [97.2]

^ Amount of Priming = UnR-Prime – Self-Prime.

Unfamiliar target trials consist of an unfamiliar target proceeded by either a famous or a familiarised prime. Familiar target trials (self-prime and unrelated prime trials) always consist of a prime and target of the same person type.

4.4.2 Results

The response latency data, from the learning experiment, were subjected to a three-way repeated measures ANOVA with repeated measures on all the following factors: Prime Type (self-prime or unrelated prime), Person Type (famous or familiarised) and Day (1, 2 or 3). The means relevant to this analysis are displayed in Table 12 (above). The analysis revealed highly significant main effects of all three factors (all *F's* > 32.2; all *p's* < 0.0001). These main effects were qualified by the presence of two second order interactions. The interaction between Day and Person Type was significant, F (2, 34) = 9.72, p = 0.0005, as was the interaction between Person Type and Prime Type, F (1, 17) = 5.77, p = 0.028. No other effects were significant (both *p's* > 0.2).

Simple Main Effects (SMEs) were computed for the Day by Person Type interaction and revealed a significant effect of Person Type on Day 1 and Day 2 but not on Day 3 (M_{FD1} = 649 ms; M_{NL1}= 749 ms; M_{FD2} = 591 ms; M_{NL2}= 651 ms; M_{FD3} = 566 ms; M_{NL3}= 597 ms). Thus by Day 3 I find no difference in average response latency to famous and familiarised items. Further analysis of the Person Type by Prime Type interaction (SMEs) showed a significant effect of Prime Type for both the famous items and the familiarised items; thus there was a significant effect of self-priming for both the famous and the familiarised items. In addition there was a significant effect of Person Type for each level of Prime Type; thus for both the self-prime and the unrelated conditions, responses were quicker to famous items than to familiarised items. The interaction here arises because first, the magnitude of priming for the famous items (82 ms) is greater than for the familiarised items (51 ms) and second, the difference between the self-prime conditions (79 ms) is greater than the difference between the unrelated conditions (48 ms) [across famous and familiarised]. Thus significant cross-domain self-priming is observed for both the famous and the familiarised items, and the analysis reveals that the magnitude of self-priming is greater for the famous items, when collapsed across the three days of testing.

Turning now to analysis of the percentage correct data, the same ANOVA model as for response latency was employed here. This analysis revealed significant main effects of both *Day (F (1.44, 24.50) = 12.56, p = 0.001) and Person Type (F (1, 17) = 17.63, p = 0.0006). These main effects were qualified by the presence of a significant interaction between these two factors, F (2, 34) = 18.17, p < 0.0001. No other effects were significant. Further analysis of this interaction (SMEs) revealed a significant effect of Day only for the familiarised items and a significant effect of Person Type only on Day 1 (although the effect for Day 2 is marginally non-significant, p = 0.058, whereas for Day 3, $p \simeq 1.0$). Thus by day 3, no reliable difference is detected, on accuracy, between the famous and familiarised items (M_{FD1} = 97%; M_{NL1}= 81.4%; M_{FD2} = 97.6%; M_{NL2}= 91.5%; M_{FD3} = 96.0%; M_{NL3}= 96.0%).

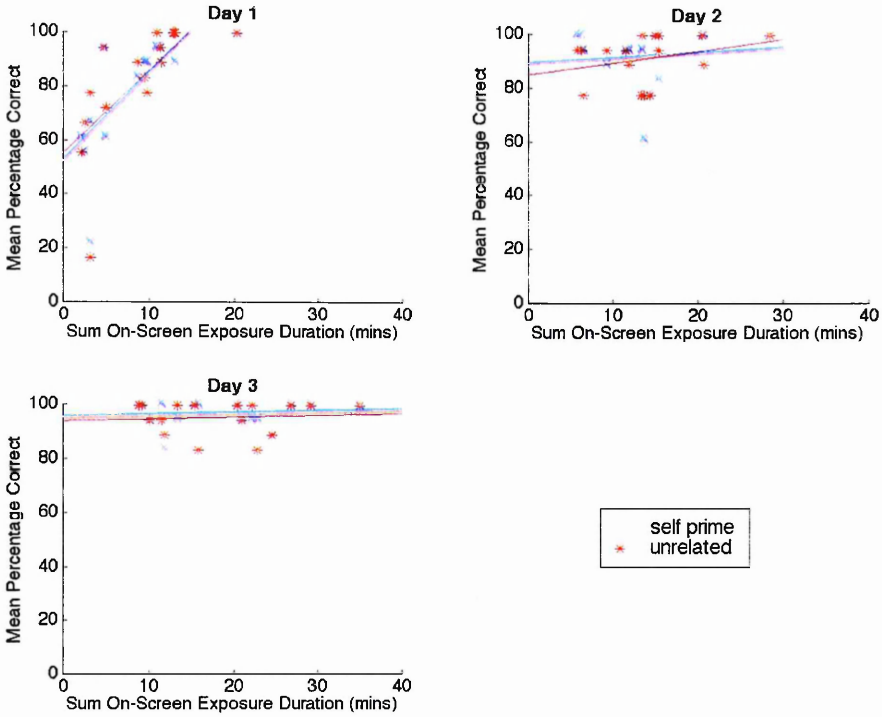

Figure 6: Mean percentage correct for the newly learned items in both the self-prime and unrelated conditions on each day of testing as a function of on-screen exposure duration (mins) for Experiment 4B [N = 16 in all cases].

Interestingly participants' performance on day 1 for each character, in terms of accuracy, can be predicted reasonably well from simple on-screen exposure duration for that character. On the other hand, the relation between on-screen exposure duration and the mean response latency is not so clear. Figures 6 (above) and 7 (next page) show the relevant scatter-plots.

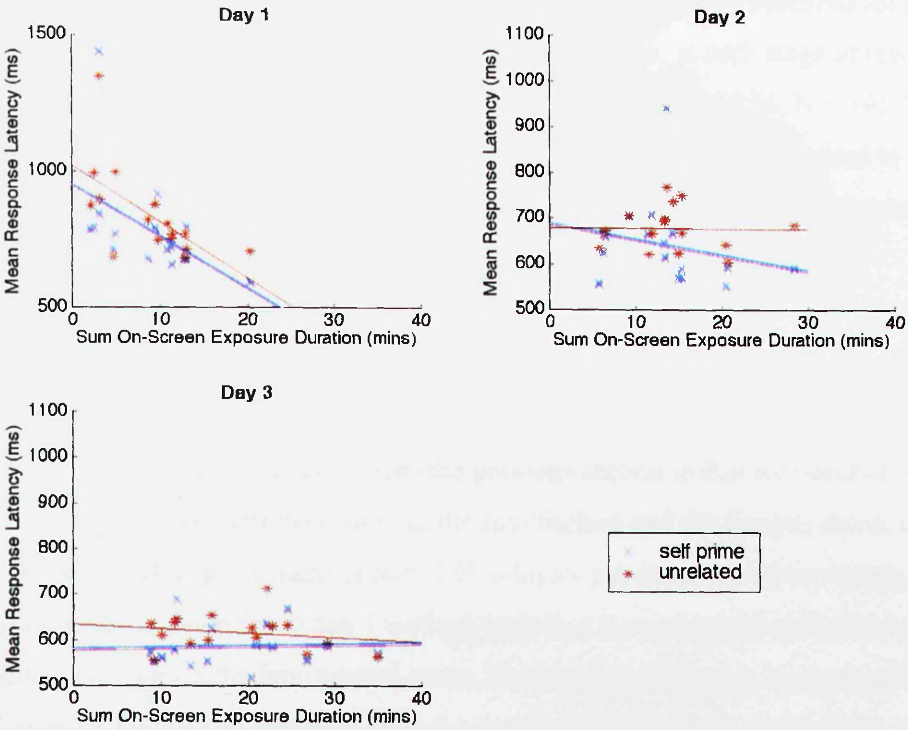

Figure 7: Mean response latency (ms) for the newly learned items in both the self-prime and unrelated conditions on each day of testing as a function of on-screen exposure duration (mins) for Experiment 4B [N = 16 in all cases]. Note the scale change on the day 2 and day 3 plots on the y-axis.

These figures demonstrate two important points. First, percentage correct for each character on day 1 is strongly, and significantly[69], correlated with on-screen exposure duration (D1-SP: $r = 0.75$, $p = 0.0008$, N = 16; Unrelated: $r = 0.69$, $p = 0.0028$, N = 16) but not on the latter days (D2 & D3, $|r| < 0.29$, $p > 0.26$, N =16 for all). Second, the correlation between on-screen exposure duration and mean response latency in the unrelated condition, for day 1, is marginally non-significant ($r = -0.62$, $p = 0.0108$, N = 16). Further, the relation of on-screen exposure duration with mean response latency in the related condition is only suggestive of a correlation ($r = -0.50$, $p = 0.0498$, N = 16). No correlations between mean response latency and on-screen

[69] I am again here using a modified alpha as for the correlations computed for Experiment 4A. Correlations were computed in an analogous manner as for Experiment 4A.

exposure duration approach significance on either day 2 or day 3 of testing (D2 & D3, $|r| < 0.21$, $p > 0.43$, N =16 for all).

I turn now to the relation between the magnitude of priming observed for each character with that character's on-screen exposure duration, at each stage of testing. These correlations were all non-significant (for all $|r| < 0.25$, $p > 0.36$, N = 16). This suggests, in concert with Experiment 4A, that a semantic variable is required to correlate with the magnitude of priming, rather than just simple on-screen exposure duration.

4.4.3 Discussion

The most important result from the previous section is that we observe reliable self-priming in this experiment for both the familiarised and the famous items, on each day of testing. Thus an average of only 8.69 minutes per character of on-screen duration (ascertained prior to day 1 testing) is all that is required for self-priming effects to emerge for the familiarised items. Furthermore, there is a stronger effect of self-priming for the famous items, than for the familiarised items, and I detect no difference in this effect according to the day of testing. It should be noted, however, that by day 3 of testing, the difference between the amount of priming for the famous and the familiarised items is only 2 ms, which calls into question the validity of the finding in the overall ANOVA, of no significant change in this difference across the days of testing. It certainly seems that there is much less of a difference on day 3, than on the earlier days, and it may just be the case that the ANOVA simply cannot detect this effect. I will comment further on this aspect of the results in the general discussion for this chapter. There is also a drop-off in the magnitude of priming for both the famous and, though to a lesser degree, for the familiarised items, from day 2 to day 3. This decrease, however, is not revealed in the statistical analysis reported above. One potential reason for this drop-off may be that the faster processing of the items on day 3 leads to less time for any semantic benefits to arise. In the general discussion, however, I will argue that another factor is the most likely cause of the drop-off, that is, repetition of pairings in the unrelated condition across blocks and across days of testing. In any event the main finding here is that self-priming effects are present by day 1 of testing for the newly learned items; thus cross-domain self-priming effects are rapid in their development. This is the result that any model of semantic familiarisation must be able to explain.

Considering perceptual processing, on the other hand, by day 3 the familiarised items are both A) being responded to as quickly as are the famous items and B) being responded to as accurately as the famous items. Both of these conclusions are important with respect to the consideration of the perceptual learning presumed to be occurring during the learning period of the present experiment. By the final day of testing the familiarised items are being responded to on the same statistical order of magnitude as the famous items, for both latency and accuracy. This suggests well-developed perceptual representations for the familiarised items by the third day of testing (or equivalently with four days of learning).

Thus the question of most pressing interest would seem to be: what is actually happening to participants' representations of the characters as they become familiarised with the characters (that is, on the four days of learning)? What is responsible for the development of self-priming for the familiarised characters, and what is driving the improvement in perceptual processing? It seems that on-screen exposure duration is an important correlate, and *may* be an important determinant, of participants' performance on day 1 of testing. This applies in terms of accuracy and perhaps also in terms of mean response latency observed. These relations, however, do not hold for days 2 or 3 of testing. The relevant correlations are all clearly non-significant. Thus while exposure duration seems to be of much importance on day 1 this is not the case for days 2 or 3. Why is this so?

Perhaps it is the case that for both the percentage correct for each character, and even for the mean response latency observed, there is a critical minimum level of exposure duration, but once this has been reached simple increases in exposure duration no longer effect these dependent variables. Consider accuracy. If the prior argument is correct then we should see that when every character's exposure duration increases to around about 5 minutes, which looks like the critical minimum here, the effect of exposure duration from then on will be minimal. This is, indeed, the case for each of the latter days here (with all points but one having accuracy greater than 0.7). Once a character has been on-screen for a duration of five minutes or over, the variation in accuracy is much reduced compared with before the five minute mark. So what is important about five minutes?

Presumably with five minutes' experience, on average, of on-screen exposure of any character, a participant has A) most likely seen the character across different scenes and contexts and thus B) formed say, n, traces of this individual across differing views and or superficialities of any one experience. Considering the model of perceptual familiarisation outlined earlier, that of the *differentiation model*, the participant's representation of the given character is most likely becoming reasonably well differentiated and robust around the five-minute mark.

A similar picture emerges if one looks at response latency as the dependent variable. At just over ten minutes here responses are consistently all faster than 800 ms (save one outlying point) on all three days. Thus this would appear to be a critical minimum for response latency. Why do the accuracy and latency relationships with on-screen exposure duration show different critical minima? Perhaps it is the case that more repetitions are needed for an effect to show through on latency than for accuracy.

4.5 General Discussion

In summary, the two learning experiments reported in this chapter have demonstrated significant effects of both within-domain self-priming (Experiment 4A, from face primes to face targets) and cross-domain self-priming (Experiment 4B, from name primes to face targets) in a population of newly learned items. This is the first time such a demonstration has been reported. In addition, the present experiments have replicated previous work on self-priming (e.g. Calder & Young, 1996) in finding significant effects for famous items onto familiarity decisions. I now turn to compare the pattern of results of the two main experiments, before comparing these experiments with others conducted by colleagues using the same stimulus materials. I also attempt to describe some plausible determinants of the perceptual and semantic learning present for the newly learned items in the current experiments. Finally, I consider the theoretical implications of the present set of experiments.

4.5.1 Comparison of Experiments 4A & 4B

4.5.1.1 Semantic familiarisation

Both Experiment 4A and Experiment 4B showed significant effects of self-priming for the learned population of items. Further, Experiment 4A revealed no significant differences between the magnitude of the self-priming effect for these newly learned items and for the control set of famous items, but Experiment 4B did show such a difference. There was a trend, however, in Experiment 4A for a larger effect of self-priming for the famous than for the newly learned items, on day 1. This is what one would expect a priori, since we presumably have more semantic knowledge for people that we know well (e.g. famous people) than for the newly learned people. Nevertheless, the effect of a greater amount of priming for the famous items in Experiment 4B does not seem to hold on each individual day in question, but is rather an effect which arises from the pooling of the differences in magnitude of priming across the three days. This effect, however, does not interact with days of testing in the relevant ANOVA, so if the difference due to day of testing exists then the ANOVA cannot detect it. The simplest interpretation is that, on balance, there does seem to be evidence for a greater magnitude of priming for the famous items on day 1 and day 2, for Experiment 4B, and probably also on day 1 for Experiment 4A, yet not so on the latter days.

In both experiments, for both the famous and, to a lesser degree, for the newly learned items there seems to be some attenuation of the self-priming effect from day 2 to day 3 of testing (though this is not revealed by statistical significance it seems a strong trend). The attenuation seems negligible for each comparison except for the difference in the amount of priming for the famous items on day 2 and day 3 for Experiment 4B (a drop of 50 ms, from 99 ms to 49 ms, greater than 2 standard errors of the relevant mean difference). Now for this experiment, the same materials were used across each day[70] which makes it unlikely that the reduction in magnitude of priming is due to any extraneous factors (unless by a peculiar participant by materials by day interaction). In sum it appears that there may be genuine attenuation of the self-priming effect with repetition across days.

Research has demonstrated, however, that the effects of associative priming (and the cross-domain variant of self-priming) with repetition priming are additive (see Bruce, Dench & Burton, 1993; Calder & Young, 1996, Experiment 3) and the current work may seem to call this research into question. None of this work, however, utilised a comparable design to that employed here. Bruce et al. only repeated their stimuli three times across three blocks whereas here, for each item (person), their identity is presented 6 times per day (within one block of trials) and thus 18 times over the three days (the same face image is shown 2 times on any given day but a different image is seen on each day by the same participant; the name is repeated 4 times on each day, in the same font within a day but in a different font across days). Calder & Young (1996; Experiment 3) present, within one block, the identity of a given person 7 times, and they present two blocks in direct succession (giving 11 name repetitions and 3 face repetitions of an identity across blocks; they also present the names twice prior to the first experimental block). Thus while these authors utilise a comparable number of repetitions of the identity of a single person across blocks, their repetition of identity is immediate and occurs across only two blocks. In the current experiment, the repetition of identity occurs across three blocks, one on each day of testing. Thus no research has used a comparable number and spacing of repetitions to that used in the present experiments.

Further thought, however, suggests a reason for this discrepancy between the current results and those of previous research: namely, the fact that the prime to target mappings in the unrelated condition, in Experiment 4B, are repeated twice per block, from A to B and again from B to A. Now, by the beginning of day 3 of testing, participants have already been exposed to four repetitions of this co-occurrence, and thus may be becoming sensitive to this co-occurrence relation. (Some support for this

[70] Although with different participants each day since the different versions of the experiment utilised different images and fonts (and unfamiliar items and block orders).

hypothesis is provided by the work of McNeill et al. (2003) who show that co-ocurring a pair of unrelated familiar faces 10 times is enough to establish what seems like the basic associative context effect for the given pair.) Although there may also be a benefit for the self-prime mappings, this is already probably at close to maximum, whereas this is most definitely not the case for the mappings of items in the unrelated conditions. Thus this mechanism could account for the attenuation of priming which is observed between day 2 and day 3 for the famous items on Experiment 4B.

The test of this hypothesis is whether the response latencies in the unrelated condition speed-up relative to the latencies in the self-prime condition across the day 2 to day 3 interval. Inspection of the relevant means corroborates this idea (M_{FSPD1} = 600ms; M_{FURD1} = 699 ms; M_{FSPD2} = 542 ms; M_{FURD2} = 640 ms; M_{FSPD3} = 541 ms; M_{FURD3} = 590 ms). Specifically, from day 1 to day 2, the response latencies in the self-prime and in the unrelated condition decrease by the same amount, about 58 ms, whereas from day 2 to day 3, the drop in the unrelated condition is around 50 ms, whereas for the self-prime condition, the drop is non-existent. Of course, other explanations of this differential drop are possible, but the current hypothesis explains the effect satisfactorily and generated a prediction, a priori, which was then corroborated.

In Experiment 4A, the pairings in the unrelated condition are also shown twice a day, though not within a block but across different blocks. So by day 3 here, a participant will have seen the pairing of items in the unrelated condition 4 times previously and thus may be becoming sensitive to this co-occurrence. However, the difference in the decrease in the response latencies here, from day 2 to day 3, between the self-prime and unrelated conditions is pretty small, only 12 ms. But it is in the correct direction, with more of a decrease in the unrelated condition than the self-prime condition. Why there should be a difference in the magnitude between the two experiments is not clear, but one reason might be that the spacing of the repetitions of these co-occurrences differs in each experiment.

In any case, despite the fact the results are not entirely clear-cut, I have demonstrated significant effects of some aspects of self-priming for the learned population of items in both experiments. Thus semantic learning is taking place for the newly learned items. These effects, moreover, are relatively rapid in their development.

4.5.1.2 Perceptual Familiarisation

In each learning experiment, the Person Type by Day interaction on response latency was significant. In Experiment 4A this was due to there being significantly faster responding to the famous items on *all* three days of testing but simply with a greater magnitude of difference on day 1, which decreases across the latter days. For Experiment 4B, however, the interaction is due to there only being a significant difference in speed of responding on day 1 and day 2, but not on day 3. The reason for the slight difference between the patterns of the interaction on response latency for the two experiments could be due to several factors, but one of the most important, I conjecture, is that the same images are viewed by participants in the task on each day for Experiment 4A but not 4B, which perhaps allows the benefit for the famous items to be maintained on day 3. Another important factor would be that I am here comparing within-domain (face to face) and cross-domain (name to face) forms of self-priming. The same interaction, moreover, is significant in both experiments on accuracy and due, in each case, to a large difference between the two sets of items on day 1, a marginally non-significant difference on day 2, but no statistical difference by day 3. Thus, in both experiments, participants are clearly learning perceptually over the course of the learning period, evidenced by both the speed-up of response and the increase in accuracy for the newly learned items relative to the famous items over the course of the learning period. Thus perceptual familiarisation is being successfully induced by the learning procedure used here.

4.5.1.3 Comparison to Other Soap Opera Experiments

Several experiments have been carried out, utilising the same stimulus materials, by my colleagues in the Face Lab at the University of Stirling (see Bruce & Burton, 2003). These experiments have tended to focus on the perceptual aspects of familiarisation. I want to comment on a few aspects of those experiments before comparing the results with those reported in the present chapter. The pertinent background to the Bruce and Burton experiments is that the internal features of a face are more important for the processing of familiar faces while the external features are more important for unfamiliar faces (see Chapter 1, section 1.3.1.1). Thus the primary aim of several of those experiments was to try to track the external to internal feature shift as faces move from being unfamiliar to becoming familiar.

Bruce and Burton investigated this by utilising the same learning methodology as used for the experiments reported in the current chapter. Participants thus watched two episodes of the soap opera a day and came back on four consecutive days. Participants were generally tested on days 1 and 4 of learning (after two and eight episodes of the soap opera). In each test phase participants made familiarity decisions to either a whole face, the internal features or the external features of either a famous, newly learned or unfamiliar face. The most important finding from this set of experiments was that the newly learned faces showed the same profile as the famous faces by day 1 of testing. That is, the newly learned faces already showed the internal feature benefit by the first day of testing (on both latency and accuracy measures). Thus two episodes of experience with the soap opera are sufficient for responses to the newly learned items to show the internal feature benefit. Thus the feature switch is occurring within a smaller time interval than two whole episodes of the soap opera.

With hindsight, this is perhaps not particularly surprising given that O'Donnell and Bruce (2001) found that participants in their study were very accurate in detecting changes made to the eyes (an internal feature) after an estimated exposure time of around six minutes per face (suggesting that their participants had become sensitive to the eyes by this time). For the set of 16 main characters used in Experiment 4B, the mean on-screen exposure duration after the first two episodes is 3.91 minutes.[71] I would not expect the relevant value for the items selected for the Bruce and Burton experiments to differ by much, given that both parties attempted to utilise the "main characters". Thus although the exposure is less, on the average, in the soap opera experiments than in O'Donnell and Bruce, there are two, key, mitigating factors. First, O'Donnell and Bruce (2001) trained their participants on 20 s clips of faces in motion with participants simply viewing the same footage over and over again. In the Bruce

[71] Compare with the critical minimum level of exposure duration which I estimate in the following section.

and Burton experiments, utilising the soap opera methodology, the experience with the critical items is of a much more varied nature. Second, the critical items in the Bruce and Burton experiments would have possessed the beginnings of a *true* semantic representation whereas O'Donnell and Bruce only had participants learn a name to each face. Thus the items in the Bruce and Burton experiments would possess a richer semantic representation, similar to what one might have in real life. The more varied experience, and the more developed semantic representation, would be expected to lead to a more robust representation for these items. In any case, the effects might still emerge in the O'Donnell and Bruce study with a shorter learning interval.

A further experiment of Bruce and Burton investigated whether semantic knowledge was required for the internal feature benefit to emerge for the newly learned items. The authors achieved this by having half their participants view the first two episodes in the normal manner but with the other half viewing the episodes with no sound and with the order of the scenes jumbled. All participants then performed the same familiarity decision task as outlined above. Again the newly learned faces showed the internal feature benefit in the condition with normal sound and scene order. More interestingly the participants in the jumbled, no sound condition also showed the same benefit. Thus semantic knowledge would not seem necessary for the internal feature benefit to arise.

With respect to the comparison between these experiments of Bruce and Burton and the learning experiments reported in the present chapter, both series of experiments show rapid effects for the newly learned items. With brief amounts of exposure the internal feature benefit emerges for the newly learned faces (after two episodes). With double the exposure, self-priming effects are present for the newly learned items (after four episodes; Experiment 4B). An interesting question to pursue would be to investigate performance of participants on the self-priming tasks after only the first two episodes of the soap opera. Would the magnitude of self-priming observed after only two episodes (mean exposure duration of about four minutes) be significant or would the semantic representations not be well developed enough yet? Moreover, one could envisage different patterns emerging here for the different types of self-priming (within- and cross-domain). These are interesting questions which should form the basis of future research in this area.

4.5.1.4 Possible Determinants of Performance

In the discussion section of each main experiment, it was shown that participants' performance on day 1, as measured by accuracy for each learned item, could be predicted well by on-screen exposure duration for the relevant item (three out of a possible four correlations had $p < 0.01$, and for the other $p < 0.1$). This was not the case for the latter days and I suggested (Experiment 4B) that there may be a critical minimum level of exposure duration, necessary for a certain level of accuracy, but that once this level had been reached variation was no longer explained by this measure. This finding is important, since when combined with the main statistical results from each experiment, especially the Person Type by Day interaction, it suggests that some other factor must be responsible for the continuing improvement in perceptual processing which occur from day 2 to day 3 in both experiments. I will consider what this might be shortly.

For Experiment 4B, on-screen exposure duration was marginally non-significant in its prediction of mean response latency in the unrelated condition on day 1 ($p = 0.0108$). The relation between on-screen exposure duration and mean response latency in the related condition on the same day, however, was non-significant but not that far out ($p = 0.0498$). Likewise for day 1 performance on Experiment 4A, on-screen exposure duration was not quite significant in its prediction of mean response latency in the unrelated condition ($p = 0.0192$) but, in contrast, was clearly non-significant in predicting response latency in the related condition. None of these relations approached significance on the latter days of testing. There is an interesting question here as to why on-screen exposure duration is consistently better at predicting response latencies in the unrelated condition as opposed to the related condition across the two experiments. The most obvious reason would be that any semantic influence is not as strong in the unrelated condition as it is in the related condition and as such one gets a purer measure of perceptual performance in the former condition. This point is arguable, however.

On-screen exposure duration for each item, moreover, did not predict the magnitude of priming for that item in either Experiment 4A or Experiment 4B at any stage of testing. There are certainly other factors however, not investigated here, which I would expect to correlate with the magnitude of priming observed at each point of testing, especially measures of semantic learning. The fact that no relation with on-screen exposure duration is found in either experiment may indicate the relative importance of semantic learning to the formation of self-priming effects, even though one might think a component of self-priming could be accounted for by just perceptual learning (especially for within-domain self-priming). Recent work by Graham and colleagues, however, shows how important semantic knowledge is even for basic perceptual memory tasks (e.g. Graham et al., 2000) and therefore perhaps we should not be too surprised by the non-significant correlations here.

Thus, on the whole, on-screen exposure duration does seem to be an important correlate of participants' performance on day 1 of testing as measured by accuracy (Experiment 4A & 4B) and may perhaps also be as measured by response latency (though this latter suggestion needs replication). Thus for the development of strong perceptual representations, on-screen exposure duration seems a potential candidate for being the first necessary step. Intuitively this makes sense. One's representations will be more differentiated the more experience one has of any given individual.

On-screen exposure duration is, however, a very coarse measure, which does not take into account what is happening during the time a character is on-screen. Perhaps this is important for predicting participants' performance on the latter days of the current experiments. It would be interesting to analyse, for instance, who is the focal character each time there is more than one character on-screen at a time (i.e. who the conversation is focused on, if any person). The most important factor, however, for predicting the magnitude of self-priming, would be the amount of semantic information known for each target item at each day of testing, since this should correlate strongly with the magnitude of self-priming observed on the relevant day of testing. This consideration comes directly from the IAC model of person recognition (Burton et al., 1990; Calder & Young, 1996). I might add that since Experiment 4B used the cross-domain task the correlation between the amount of semantic knowledge known and the amount of priming observed should be larger in this task than it is for the within-domain task where a perceptual mechanism also contributes to the priming effect. These types of analyses should form the basis of future work in this area.

I now move to consider the theoretical mechanisms which may be responsible for the patterns of results which occur in the present experiments.

4.5.2 Theoretical Mechanisms & Theoretical Explanations

The IAC model of Burton et al. (1990) predicts self-priming for familiar faces and I do find significant self-priming for both the famous items and the newly learned items in both learning experiments. Thus the IAC model would seem to be corroborated by this series of experiments. It certainly can account for most of the data on self-priming for the famous items (given the design limitations of Experiment's 4A & 4B). It does not, however, provide a satisfactory model of the process of familiarisation, which is what is required to explain the data from the newly learned items in the present experiments. More specifically, the IAC model can explain the performance of participants on the newly learned items at test by some given day (when the item is deemed to be familiar), but the assumption would be that a new individual has just been added to the current system, with minimal explanation of what happens to make an unfamiliar person familiar. This illustrates one of the most significant problems with the IAC model as it currently stands (Burton, Bruce & Hancock, 1999): namely, that it does not account for the process of person familiarisation. Yet an adult human's person recognition system is constantly learning about new individuals in a similar manner to that which occurs in the present experiments. The person recognition system is not static, it is dynamic. Thus, although the IAC model has served this area of cognitive science very well, we now need a stronger theory of person recognition, which encompasses not just a *snapshot* of the healthy adult's person recognition system, but which begins from the processes of person familiarisation.

4.5.2.1 Perceptual Familiarisation

With respect to the *perceptual familiarisation* of the newly learned items, the *differentiation* model of McClelland & Chappell (1998) would seem to be able to explain the principal finding from this series of experiments (on accuracy). The principal finding, in regard to perceptual familiarisation, is the Person Type by Day interaction, which reliably shows through on both latency and accuracy measures, in both experiments.

Now with respect to accuracy, the *differentiation* model would assume that as the learning period progresses, participants' representations of the newly learned items become ever more differentiated with increasing experience. Thus on day 1, participants' representations of the newly learned items are not well differentiated, on the average, and thus accuracy is very poor (this is not the case for the famous items at this stage). As the learning period progresses, however, the representations of these newly learned items become more differentiated due to increased experience, in comparison to the famous items (which have no such learning period), thus accounting for the increase in accuracy to statistically similar levels as that for the famous items, which is seen in both experiments across the three days of testing. In addition, the magnitude of effect which each experience of an item has on the representation for that given item will be different for the famous and the newly learned items, since they are at different points on the differentiation scale to begin with. Thus, with respect to accuracy, McClelland & Chappell's model accounts for the data from the present set of experiments very well.

The process of differentiation, moreover, would be expected not just to effect accuracy but also to have some influence on response latency. The *differentiation* model, however, does not include a mechanism or analogue of response latency. Thus in this respect, as a model of person familiarisation, it is lacking. Clearly we want a model that accounts for both latency and accuracy response measures.[72] Thus what model can account for the latency changes which occur in the processing of the newly learned items across days? Logan's model of automaticity (1988; 1990) suggests that with more experience of just about any item, we become faster at processing that given item (until performance reaches an upper limit). Thus it would not be hard to imagine

[72] It should be noted that the *differentiation* model was not designed to be a model of person familiarisation, rather a model of single-item recognition memory, but that I am adapting it for this purpose.

that in the current series of experiments, response latencies to the newly learned items are decreasing in speed over the three days of testing since participants are experiencing these items more and more over the course of the learning period (and through repetition of the task from day to day of testing). For the famous items, however, this is not the case: there is no learning period for these items. There is still repetition, however, of these items from day to day of performing the task and thus participants' latencies to the famous items also decrease over the days of testing – just not by as great a magnitude as for the newly learned items. In addition, the effect of a repetition on response latency for the famous and the newly learned items is most likely different, with a greater benefit for the newly learned items than for the famous items at least initially, due to the pre-experiment levels of experience with the respective sets of items (cp. Logan, 1988; Experiment 1). Thus we can explain the greater decrease in response latencies for the newly learned items as opposed to the famous items.

Thus we can explain well the *perceptual familiarisation* that is occurring in the current series of experiments, albeit using two different models of human memory, one to account for each response measure. The goal, of course, is to have a unified theory of the process of person familiarisation. Nonetheless, to identify models which can account for aspects of the process of familiarisation is a first step in the direction of the unified theory. The two principal mechanisms accounting for the data here are the amount of experience a participant has with an item, and the effect each experience has on the representation for the given item. These are two factors which would have to be included in any future model of the processes of person familiarisation.

I note, in addition, that the *differentiation* model is directly sensitive to a participant's experience with any given item, which suggests why on-screen exposure duration is such a good correlate of participants' performance, on accuracy, on day 1 of testing in the current experiments. Why, however, it is only a good correlate on day 1 but not on the latter days of testing is not explained by the model. It should be noted, however, that a relationship of on-screen exposure duration to performance on the latter days may still be found if the stimuli of the newly learned items were presented in a degraded mode – that is, the representations may still be improving with on-screen exposure duration over the latter days of testing, yet I cannot detect these effects due to performance for these items being reasonably high by this stage.

Given, on the other hand, the results of Graham and colleagues referred to earlier (e.g. Graham et al., 2000), which suggest that semantic knowledge has strong effects on recognition memory tasks, it is not perhaps surprising that on-screen exposure duration is only a good correlate of performance to begin with. Beyond reaching a critical minimum level of on-screen exposure duration, perhaps semantic knowledge is more important in terms of improving the robustness of the representation. Thus any complete model of even perceptual familiarisation may have to include a semantic component.

4.5.2.2 Semantic Familiarisation

The principal findings of the current series of experiments with respect to the semantic familiarisation of the newly learned items is the reliable effect of self-priming for the newly learned items, in both experiments, and the evidence for there being a greater magnitude of priming for the famous items than for the newly learned items on days 1 and 2 of testing (Experiment 4B). Furthermore I could detect no significant differences in the magnitude of the self-priming effect for the newly learned items across the days of testing, in either experiment. The main conclusion is that self-priming effects emerge rapidly (Experiment 4B).

4.5.2.2.1 Surprising Findings

Two of these findings are surprising. First, the fact that no significant differences were found between the magnitude of the self-priming effect for the newly learned items as opposed to the famous items in Experiment 4A is unexpected, since I would have expected that, especially on day 1, the effect of self-priming would be significantly greater for the famous items, since participants already have much semantic knowledge for the famous items, while they will only have a small amount of knowledge for the newly learned items. Second, and complementary to the first, is that

I find no reliable increase in the magnitude of the self-priming effect for the newly learned items across the days of testing, for either experiment. I would have expected the magnitude of self-priming to increase for these items across days, since participants are presumably increasing their semantic knowledge for these items across the learning period. This point applies equally well to each of the learning experiments reported in the present chapter. There are, however, several complications and I now progress to address the complications as they pertain to each of the surprising findings in turn.

With respect to the first surprising finding, there is a trend towards a greater magnitude of self-priming for the famous items than for the newly learned items, on day 1, for Experiment 4A. Thus although not significant in the overall ANOVA, the relevant magnitudes of priming are, 41 ms and 16 ms (for the famous and the newly learned items respectively). Thus the magnitude of the self-priming effect for the famous items is over double that for the newly learned items. Now in Experiment 4B, the magnitude of self-priming for the famous items, on day 1, is 1.78 of a standard error greater than that for the newly learned items (and is 1.96 of a standard error greater on day 2).[73] For Experiment 4A, in contrast, there is little evidence for even a trend here, with the magnitude of self-priming being only 0.41 of a standard error greater for the famous than the newly learned items here. It should be remembered, however, that the pattern of self-priming was complicated on day1 of Experiment 4A due to both the altered design and the effects of visual dissimilarity. I do not know whether these effects would be constant for the famous and the newly learned faces or not. These differences could be the reason why there is little suggestion of an advantage for the famous items with respect to the magnitude of self-priming. In conclusion, tentative support is provided for the initial expectation of finding a greater magnitude of priming for the famous items on day 1 of testing, across both experiments.

The second surprising finding, that of there being no increase in the magnitude of self-priming for the newly learned items across the days of testing (and thus across the learning period) I turn to now. For Experiment 4A, the magnitude of priming for the

[73] Using the t-distribution, for an N of 18, two means would have to differ by greater than or equal to 2.101 standard errors to be significant (using an alpha of 0.05; two tailed). This is why I compare the differences in terms of standard errors – they are directly related to simple significance tests between means.

newly learned items on day 2 is 1.67 of a standard error greater than on day 1. Once again, while clearly not significant, there does seem to be a reasonably strong trend here in the proposed direction. In contrast, the same comparison, for Experiment 4B, reveals that the magnitude of priming for the newly learned items on day 2 here is 0.69 of a standard error greater than on day 1. The reason why these differences are quite different could be due to the very noisy nature of the data from Experiment 4A on day 1 (due to the design and visual dissimilarity issues alluded to before) thus resulting in an artificially large difference between day 1 and day 2 amounts of priming (the standard error of the mean magnitude of priming on day 1 for Experiment 4A is 50 ms whereas for Experiment 4B it is only 26 ms). Thus there does not seem to be strong support for the initial expectation of the magnitude of priming increasing over the course of the learning period – yet this seems to be a most intuitive prediction.

A possible reason why this is not the case is that alluded to earlier when discussing the attenuation of the priming effect for the famous items on day 3 of Experiment 4B. Simply put, since the pairs of items in the unrelated condition are repeated twice a day and four times by the beginning of day 3 of testing, participants may well become sensitive to this co-occurrence relation. Thus any increase in the magnitude of priming across the days, for the newly learned items, will be offset by the increasing co-occurrence between the items in the unrelated condition, thus reducing any priming effect. While for the famous items I expected to see a greater reduction in the latencies of the unrelated condition than the self-prime condition, for the newly learned items this effect may be minimised by the increasing semantic knowledge content for these items. For Experiment 4B, this hypothesis fits the evidence, a posteriori, rather well, with a larger decrease in the latencies in the unrelated condition from day 2 to day 3, than in the self-prime condition, but with the magnitude of this decrease being much smaller than for the famous items (12 ms here as opposed to 50 ms for the famous items), suggesting that the reduction in priming is minimised here relative to for the famous items. In contrast, from day 1 to day 2, the decrease is larger for the self-prime condition, which makes sense, since at this time any effect of co-occurrence will be small, whereas the effect of semantic knowledge will be larger.

For Experiment 4A, however, the picture is not as clear. There is a greater decrease in the unrelated condition from day 2 to day 3 than in the self-prime condition, for the newly learned items. This is the reverse pattern to that for the change from day 1 to day 2, where there is a greater decrease in the self-prime condition. So far this is the same pattern as for Experiment 4B. The problem here is with the comparison to the famous items. The newly learned items show a bigger decrease from day 2 to day 3 in the unrelated condition (25 ms to 12 ms) than the famous items. This is opposite to Experiment 4B and is unexpected since the semantic knowledge content for the newly learned items should be increasing relative to that for the famous items leading to less of a reduction in latencies in the unrelated condition for the newly learned items. Some possible reasons for this difference are that the spacing of the co-occurrences of items in the unrelated conditions is different in each experiment and the other design differences between experiments but it is difficult to specify a reason in detail.

Thus, in conclusion, I have outlined some potential reasons why two surprising effects are found in the present set of experiments. On the basis of these reasons I have three future recommendations for research in this area: firstly, that in within-domain self-priming experiments (Experiment 4A) visual dissimilarity must be controlled within tight limits: that is, both images must be of equal likeness to the target person, for the participant at the appropriate stage of testing. Secondly, that repetition must be eliminated, or at least balanced within blocks across self-prime and unrelated trials, in within-domain self-priming experiments. Finally, I suggest that the pairs of mappings in the unrelated condition should be altered across days, to prevent any effects of co-occurrence from diluting any possible priming effect. If these procedures are followed, one should have a much more refined investigation.

4.5.2.2.2 Models of Semantic Familiarisation

The main finding on semantic familiarisation, to repeat, is that of significant effects of self-priming for the newly learned items, and further the rapid development of these effects. What type of model can account for such semantic learning? The first point to note here is that none of the models referred to earlier, which account very well for the processes of perceptual familiarisation, are of much use when trying to explain the processes of semantic familiarisation. Neither of these models goes, in any depth, beyond single item recognition and repetition. Clearly any model of semantic familiarisation must have a mechanism by which semantic knowledge can be linked to perceptual knowledge. The model of Rogers et al. (2004) does, however, have implications for a theory of semantic familiarisation. In this model, the authors take semantic knowledge to be that which *links* perceptual and verbal knowledge about a given item. So semantic representations in this model have no semantic content, the content is in the perceptual representations themselves. The semantic system simply maps the relevant perceptual representations from different modalities to one another for any given item. The semantic system is, however, structured. Thus, " [...] *semantic knowledge emerges from the interactive activation of modality-specific perceptual representations of objects and statements about those objects*" (Rogers et al., p2). This model seems to offer some promising mechanisms for a theory of semantic familiarisation of people. I consider these possibilities in the final chapter of the present thesis.

4.5.3 Conclusion

In this chapter I have used self-priming to demonstrate that semantic learning is rapid for newly learned items (Experiment 4B). In addition, I have also shown that perceptual learning of the newly learned items results in large gains in perceptual processing across the three days of testing (as compared to the control set of famous items; Experiment 4A & 4B). This perceptual change with learning can be explained with current models of human memory. The rapid development of self-priming effects, in contrast, requires more development of such models to incorporate semantic familiarisation. In concert with studies investigating feature specific perceptual changes occurring with familiarisation these experiments suggest that the processes of familiarisation are rapid. About eight minutes of exposure of a varied, quasi-realistic, nature will result in the emergence of cross-domain self-priming effects for a given character and further will result in the internal feature benefit for processing of the characters facial features. Thus less than ten minutes is all that is required for two significant benchmarks to be in place on the way from unfamiliar person to highly familiar.

An interesting further question is the extent to which experience with a set of newly learned people needs to be maintained for that set of items to continue to display such effects. Thus if I retested participants on the cross-domain task say a month, or six months or even a year later, would they still show the effects present in the experiments reported in this chapter (and the internal feature benefit) for the newly learned items? This would be an interesting question to pursue.[74]

[74] This question was put to me by Alan Baddeley at the XIII ESCOP (European Society for Cognitive Psychology) conference in Granada, Spain, Sept. 2003.

Chapter 5

General Discussion – Summary, Evaluation and Theoretical Development

5.1 General Introduction

In this final chapter of the present thesis I offer a summary and an evaluation of the set of experiments carried out. I then describe what I think would be the most productive avenues of future research for the areas covered by the present thesis. In addition, I attempt some theoretical development on person familiarisation, relying heavily on previously published theories of human memory processing. Finally I derive some more implications for future research

5.2 Summary

The aim of this thesis was to explore the familiarisation of new people, with especial regards to the processes of semantic familiarisation. In the first experimental chapter (Chapter 2), I explored the ability of a script-like representation to account for the learning of new person-specific knowledge. This script view was partially supported over two experiments, although alternative explanations were preferred. Experiment 2A showed that participants were faster, after an initial learning period, to verify a previously non-mentioned but implied occupation about a newly learned individual than a non-implied occupation. There was a non-significant trend in Experiment 2B, moreover, towards participants being more likely to recall the previously non-mentioned implied occupation, after a comparable learning period. I also examined several reasons for the discrepancy between the recall and verification experiments. An explanation at multiple levels was preferred for the basic effect (Experiment 2A). I proposed that a full explanation would have to include aspects of stereotyping / inferences ideas plus a specific memory explanation of how the former works (within an implemented model, if possible). There were three different specifications of this broad outline. The first two have in common the following idea: at either learning or test (this differentiates the two), participants form a third order probe (e.g. male, flies long hours most days, travelled all over the world) and this leads to retrieval to a set of occupations from memory, with greater activation for the implied than the non-implied occupation (or perhaps just the implied occupation is retrieved). If, further, participants retrieve the set of implied occupations at learning (specification one) and attend to it then it will be encoded into memory, presumably alongside information about the newly learned person. Critically, however, the implied occupation would be represented more strongly than the non-implied occupation (mirroring the retrieval strength). Hence the faster processing of the critical occupations on the verification task (Experiment 2A). This idea could also account for the suggested effect of a greater probability of recall of such occupations on the cued-recall task (Experiment 2B). This is the specification I think, on balance, is most plausible. I cannot, however, rule out the two following specifications, based on congruency, at present.

If, in contrast to the first specification, a minimalist explanation of the learning phase is preferred then the same process described above could occur at test (the third order probe causing retrieval of selective information). That is, the face would cue retrieval of the information from the learning phase and this information (retrieved statements plus face) would form a third order probe which would lead to retrieval of information from long-term memory (for the example given above, many more instances of a male pilot would be retrieved and hence the implied occupation would be the most strongly activated in the retrieved information). Congruency between the retrieved information in memory and task constraints could then explain the results for Experiments 2A (and the suggestive effect in Experiment 2B). There is another mechanism, moreover, by which congruency could work (specification three). Congruency in this case would be computed as the match between the memories generated by the presented occupation (the features of the occupation) with those of the learning information. The idea here is that the presented occupation leads to retrieval of information associated with it; more instances of a male pilot should be retrieved than a male air steward. No selective retrieval on the basis of the learned information is required here at test. Thus either of the two congruency explanations or some combination could be at work.

Further, although it is clear that either a learning phase or a test phase explanation can explain the data here I emphasise again that whether the critical occupation is inferred at learning or not the same objective result remains, namely greater sensitivity to expectancy congruent information. In addition, although I am espousing the theoretical ideas more in terms of instance-based models I do think that a modified semantic network model could also account for the present set of results.

In the postscript to this chapter I offered a critical experiment which should reveal whether the basic effect on verification is solely due to intentional learning and whether it is learning or test based, respectively. The chapter extends, in any case, thinking about stereotypes / inferences to cognitive research on person recognition. Advantaged processing of expectancy congruent information is a fundamental part of the healthy operation of the cognitive system and as such requires to be modelled in any theory of person familiarisation.

The second experimental chapter (Chapter 3) investigated the structure of participants' person-specific knowledge representations. Using both recall and verification tasks I demonstrated different patterns of benefit for famous people and a set of characters from a soap opera. Famous people showed a consistent advantage for the recall and the verification of occupational information whereas the soap opera characters showed, in contrast, an advantage for the recall of relational information and no difference between the verification of each type of information (occupational and relational). In the discussion to chapter three I argued that the factor which is most likely responsible for determining the structure of participants' representations (as reflected in the experimental tasks carried out) was some measure of the amount of experience that a participant has with a given individual and type of information.

A preliminary environmental analysis (following Schooler & Anderson, 1997; Anderson & Schooler, 2000) corroborated this idea for famous people. That is, it showed that participants would be exposed much more often to famous people in conjunction with information about their occupation than their relations. Thus one principal determinant of the structure of person-specific knowledge would seem to be the amount of experience one has with a given person and a given type of information. I conjecture this factor also accounts for the observed faster processing of occupational relative to nationality information for famous people (see Johnson & Bruce, 1990) though I have not corroborated this with an environmental analysis. The work in this chapter then has highlighted the importance of the broad co-occurrence structure of the environment in determining person-specific knowledge representation. What type of information tends to co-occur most often with the target item? This factor will have to be incorporated in any model of person familiarisation. This, however, is only one factor which will affect the structure of person-specific knowledge representation – there will be many more (see section 1.4 on future research).

The final set of experiments (Chapter 4) attempted to investigate the processes of familiarisation in an on-line manner. A self-priming task was employed on three occasions as participants gradually became familiarised with a set of soap opera characters. Experiment 4A investigated within-domain self-priming and revealed significant effects for the soap opera characters (and for the famous control items) on each day of testing, and furthermore no difference was observed between the magnitude of the effect for these characters and that seen for the famous control items. No difference, moreover, was detected in the magnitude of priming observed across the three days for the soap items. Experiment 4B, in contrast, investigated cross-domain self-priming for the soap opera characters and again revealed significant effects of self-priming on each day of testing for both the soap opera items and the famous items. The control famous items, however, showed significantly greater priming than the soap opera items (though visual inspection suggested that this was limited to the first two days of testing). Again, no significant increase in the magnitude of priming was observed for the soap items across days.

I reviewed two surprising findings with respect to these processes of semantic familiarisation. First, the fact that no greater priming was observed for the famous than the soap items on day 1 in Experiment 4A I put down to the design problems with that experiment. Second, the finding of no significant increase in the magnitude of priming for the newly learned items across days I explained as being due to a design issue with both experiments: namely, that the mappings of items in the unrelated conditions remained constant across days. I conjectured that participants learn this co-occurrence relation and this reduces the magnitude of priming for both the newly learned items, and even more so for the famous items, across the three days of testing. Thus I proposed several recommendations for future research to take into consideration in order for an improved experimental design. The main result, in any case, on semantic familiarisation is the rapid development of the self-priming effect (shown clearly in Experiment 4B). The theories of general memory processing, which are of much use in explaining the development of perceptual familiarisation, require further development to explain the rapid development of such semantic effects.

With respect to the perceptual familiarisation of the newly learned items, both experiments showed similar patterns. On both accuracy and latency measures, both experiments revealed significant Day (Day One, Two or Three) by Person Type (Newly Learned or Famous) interactions. In each case this was due to there being a large difference between processing of the newly learned items and the famous items on the first day of testing which decreased in magnitude across the three days of testing. By the third day of testing accuracy in both experiments and latency in Experiment 4B was non-significantly different for the famous and the newly learned items. For Experiment 4A, latency was significantly faster for the famous items than the newly learned items on each day of testing although the magnitude of this effect decreased across the days of testing. Thus significant improvement is observed in the perceptual processing of the newly learned items with increasing experience of the soap opera. That is, perceptual learning of the soap opera characters is occurring across the learning period. I argued that the results on accuracy could be well modelled using McClelland and Chappell's (1998) *differentiation* model of recognition memory. Further the data on latency could be well accounted by a model such as Logan's (1988). Thus perceptual familiarisation could be explained well by current models of human memory, even if a different model was required for each dependent measure.

5.3 Evaluation

5.3.1 The Experiments

The motivation for the present work originated in the fact that current models of person recognition do not account for the processes of familiarisation. Yet most of these models implicitly assume such a process. Thus the goal of the present thesis was to provide evidence which would be useful in constraining full-spectrum models of person recognition, that is, models inclusive of the processes of familiarisation. I focused on semantic familiarisation, in the main, since previous research on this component of familiarisation has been largely non-existent, whereas several studies have looked at perceptual familiarisation.

The constraints which emerge from the experiments reported in this thesis are the following. First, in any complete model of familiarisation, context sensitivity in learning is likely to be necessary. Thus whatever methods of memory representation and processing are employed in such a model they must be capable to support, minimally, the subsequent improved processing of expectancy congruent material (maximally, it may have to support inference generation at learning). This was highlighted from the first experiment reported in this thesis (Chapter 2; Experiment 2A) and was suggested by the non-significant trend of Experiment 2B. Allowing past performance to bias future performance is really what human memory is all about (c.p. Anderson, 1990). Another important point to emerge from this line of work, even though I could not demonstrate it conclusively, is the issue of how pre-existing knowledge affects the learning process. Any model of familiarisation may well have to allow for pre-existing knowledge to be able to affect learning.

Second, any model must be sensitive to the co-occurrence relation between each individual and the types of information that person tends to appear with. Thus for famous persons, the model would have to learn that they co-occur more often with their occupational information than any other type. This then is one factor which likely determines the structure of person-specific knowledge representation. The importance of this factor was highlighted in Chapter 3 of the present thesis (Experiments 3A-3D).

The last experimental chapter of the present thesis (Chapter 4) showed that newly learned items behave similarly to famous items after only brief periods of learning. With regards to perceptual familiarisation any model should be able to replicate the Day by Person Type interaction which is the main finding here. That is, it must be able to show a large difference in performance between the two types of item (newly learned and famous) early during the learning period and further that this difference decreases and in many cases disappears with more learning. I have suggested that the models of McClelland and Chappell (1998) and Logan (1988) can account for these findings for accuracy and latency measures respectively. With respect to semantic familiarisation the implications here for any model of familiarisation are not so clear. The main finding, however, is clear and that is that any model will have to be able to show quite rapid effects of self-priming (after, on the average, 8.69 minutes of exposure for a character) and thus of semantic learning of the newly learned items. The exact magnitude of these effects, however, and the comparison to famous items, will have to wait for future research before stronger conclusions can be drawn.

Thus, in sum, the experiments reported in this thesis have provided data which any complete model of familiarisation will need to be able to explain. I now turn to consider which models and methods of representation and processing provide the best explanation for the findings reported in this thesis, considered as a whole.

A full explanation for the main finding reported in chapter two of the present thesis I argued must consist of a general explanation in terms of the importance of inferences / general stereotypes to memory processing and a more mechanistic specification in terms of models of human memory (either instance based or semantic network based). The basic idea, on two specifications, was that a third order conjunctive probe (e.g. male, works in local hospital, like to keep his patients well) activates long-term memory and leads to retrieval of the implied occupation (doctor) with a greater probability (or activation) than the non-implied occupation, at either learning or test. If a set of occupations are retrieved at learning then they may well be attended to and hence become part of the mental representation for the relevant individual, thus allowing for subsequent faster processing (and possibly also to a greater probability of recall) to the more strongly represented occupation (i.e. the implied occupation). If not, then retrieval of the same information at test will allow for congruency to affect any decisions. Thus the explanation, in either case, rests on a multiple-cue constrained retrieval from long-term memory. The other type of explanation involves the occupation presented at test retrieving knowledge associated with it, and using that knowledge to compare with the information learned from the scenario, thus allowing congruency to be computed. This explanation, however, would be much weakened if a significant effect were to be found on a recall task at test where there is no presentation of the occupation (unlike the verification task). The fact that a large, but non-significant, trend was found in the correct direction in Experiment 2B speaks against this view, to some extent.

I think, further, that an instance-based account could explain these results, on any particular specification (e.g. Whittlesea, 1997), but a semantic network model may also be able to do so. The latter model may well have to allow for the spread of activation to be determined by multiple contextual elements and also be able to learn the association between each individual and the occupational descriptive statements (at a minimum). These processes seem to be better formulated in existing instance models. Thus it seems, on the whole, that while an explanation is possible on both an instance view and a semantic network view that the explanation perhaps falls out in a simpler manner on an instance view. This is not to say, however, that the network view may not prove correct.

In the general discussion to the second set of experiments reported in the present thesis (Chapter 3) I did not explicitly consider models of memory representation as that was not the primary interest. I will here consider, however, what type of representation could best account for those results. The basic result seems to be that greater experience of information of a given type with any individual leads to better processing of that information for the same individual (as measured by increased probability of recall and decreased verification latency). Instance models would be able to explain this result as due to the increasing number of traces of a certain kind with a certain individual. One could also imagine a semantic network where the link between the relevant individual and type of information is strengthened with each subsequent repetition. Thus these experiments do not strongly favour one mechanism of representation over the other.

Finally, for the set of experiments reported in the final experimental chapter of the present thesis (Chapter 4) I considered explanations in two main areas. First, for perceptual familiarisation I argued that the models of McClelland and Chappell (1998) and Logan (1988) could account for different aspects of the present results. Second, as the results on semantic familiarisation were not conclusive I did not attempt a theoretical account here (though see section 1.2.5 of the present chapter). The two models used to explain the results on perceptual familiarisation, however, are somewhat contradictory. The first represents each item by means of a detector which is accessed each time the item is presented (with a given probability) whereas the second represents each repetition of an item in a different memory trace. Thus the first model is abstractionist whereas the latter is a multiple trace theory.

Taken as a whole, then some experiments reported in the present thesis suggest an instance-based representation would be somewhat simpler (Experiments 2A and 2B), whereas some are ambivalent with the question of mode of representation (Experiments 3A-3D), while further some suggest both types of representation are needed for different response measures (Experiments 4A and 4B). Thus it seems that with respect to the mechanism of memory representation, this thesis has produced mixed results. No one type emerges as a clear winner. Anderson (1990) has argued that numerous mechanisms will always be able to account for any set of data, with the clear implication being that either a multiple trace or a strength-based view can account for any given set of data. As such he recommends developing theories which begin at a higher level than just mechanism. Perhaps this is what is needed here. That is, a more developed theory of why the human memory system should use one form of memory representation over another, or perhaps for why it may use both.

Work by Marsolek and his colleagues have shown that the sensitivity of repetition priming to surface manipulations of stimuli appear to disproportionately affect presentations to the right hemisphere. These results extend over the visual (both words and objects) and the auditory domains (Marsolek et al., 1992; Marsolek, 1999; Schacter et al., 1993; [the latter cited in Bowers, 2000]). Marsolek (1995) has also shown that the left hemisphere is more sensitive to abstract relations than the right hemisphere. Thus the view to emerge from this work is that the two hemispheres of the brain are differentially sensitive to specific and abstract information. Marsolek further argues that there must be two types of system – one sensitive to specific information in the RH and one sensitive to abstract information in the LH. The need for separate systems is based on a computational argument which suggests that the type of computation to be performed by each subsystem is incompatible with that being performed by the other subsystem (Marsolek et al., 1992). In contrast, however, Logan (2002) has presented a new theory of attention and categorization which is solely instance-based in nature though accounts well for much data in these fields. Thus across many fields there is not general agreement on how memories are represented in the brain.

The aim of this thesis, of course, was not to adjudicate between these two modes of representation and as such I will not consider the matter further. In the absence of compelling evidence ruling out one mode of representation I will, for now, adhere to the view that both modes of representation are likely to be used in the human brain.

5.3.2 On Methodology

In the series of experiments reported in chapter four of the present thesis I successfully perceptually and semantically familiarised participants with a novel set of people. (The same methodology was used to familiarise participants with soap opera characters in Chapter 3.) The specific learning methodology employed there has one major advantage (and many minor) and I will briefly expound this here. Participants are *naturally* familiarised to the characters to a high extent. Thus these experiments possess a good degree of ecological validity with regard to the learning phase. Compared to an experiment (like Experiments 2A & 2B reported in this thesis) where participants merely have to learn a face and associate some information to it, this methodology is many orders of magnitude richer and more comparable to real-life. Of course there is some lack of experiment control with such a methodology but I do not advocate the use of one methodology to the exclusion of the other, simply the conduction of a greater proportion of *naturalistic* studies in person recognition (see Young, Hay & Ellis, 1985, for a rare naturalistic study in person recognition). See the end of Chapter two for an assessment of the different types of learning methodology.

5.4 Future Research

I have already outlined a critical experiment in the postscript to chapter two of the present thesis and I will not repeat that here. If successful that experiment would allow one to distinguish whether the principal finding reported in that chapter was dependent on intentional learning, and most importantly, whether the effect was learning based or test based in nature. I would like, however, to suggest some further lines of research for this area. I think the most important thing to pursue here is how expectancy congruent material is facilitated in terms of processing. Assuming that the occupation was inferred at learning (as I strongly suspect but which the critical experiments will tell definitively) then the applicable explanation was that a conjunctive probe consisting of three different pieces of information acted as a retrieval cue to memory and thus the critical occupation was retrieved in response to the conjunctive cue. This is the area I think most important for future research, if the results of the critical experiments show the effect is learning based. How does attention control the selection of information to be included in the cue? How much attention is required, if the process occurs at learning, for the retrieved chunk of information to be subsequently represented in memory? Is the process just a one trial event or does repetition play a role? Are multiple occupations activated or just the most strongly implied? These are the types of question which future research should address.

The experiments reported in chapter three, which investigate the structure of person-specific knowledge, are simply a first step in that process. I have only utilised one main determinant in my explanations, namely the amount of experience one has with a given individual and a given type of information. The time is now ripe, I think, to apply some of the methods used by, for instance, McRae et al. (1997) and Garrard, Lambon-Ralph, Hodges & Patterson (2001) to investigate the internal structure of semantic representations to representations of person-specific knowledge. That is, to more fully explore the structure of representations of person-specific knowledge.

McRae et al., for example, carried out a feature generation task where they had participants generate features to given object concepts. From this they derived two modes of concept representation. The first mode of representation was simply in terms of individual features which a concept possessed (determined from the feature generation study they had carried out). The second mode, in contrast, involved representing each concept in terms of correlated features. Correlated features, in this context, refer to pairs of features which co-occur across basic level objects (McRae et al., 1997). An example would be that *breathes* and *eats* are correlated features because things which breathe also tend to eat (i.e. animals). These two modes of semantic representation were then used to successfully predict performance in a number of semantic tasks (semantic priming and verification tasks).

The methods of McRae et al. (1997) should thus be applied specifically to investigate the structure of person-specific knowledge. A first step would be to conduct a *tightly* constrained feature generation task, in response to famous person names and faces. Different modes of representation (such as individual feature and correlated feature, ascertained from the feature generated task) could then be used to try to predict performance on semantic tasks such as associative priming and verification, whilst controlling for other important factors (e.g. familiarity, frequency etc). Such a step may well progress our understanding of the internal structure of person-specific knowledge by a large extent.

The IAC model of Burton and colleagues (1990; 1999), for instance, explains associative priming due to shared semantic information between the prime and target in the related condition. With an objective measure of this variable (in terms of individual features or correlated features) one could explicitly investigate whether this predicts the magnitude of priming once, for instance, a measure of co-occurrence has been partialled out (with the co-occurrence measure obtained in a similar fashion to the environmental analysis of chapter three). This would be a strong test of the IAC model's account of associative priming. Thus I think a comparable study to that conducted by McRae et al. could answer some important questions in the domain of person recognition. Further such a study could be conducted for both a set of famous people and for the set of soap opera characters used throughout the present thesis.

Turning now to the final set of experiments, reported in chapter four, I have several suggestions for future research here. The first recommendation would be to repeat the studies I have carried out using a modified design as outlined in the chapter four general discussion section. The most important modification, which applies equally to cross-domain and within-domain tasks, and indeed any associative priming test which is repeated across days, would be to change the pairing of items in the unrelated conditions across the days of testing. The fact that I did not do so, I conjecture, accounts for at least two unexpected findings in the results on semantic familiarisation in that chapter.

I do, however, have a few experiments to suggest which I think may well spur future research in this area. First, to attempt to isolate the effect of semantic knowledge on the familiarisation process, I propose conducting the following experiment. Briefly, participants would be randomly assigned to one of two conditions: visual, or audiovisual. Participants in each condition would watch the same set of episodes from the soap opera. Further, the manipulation would ensure that one group of participants would be exposed solely to visual stimuli, presumably leading to an impoverished semantic representation. The second group would be exposed to both auditory and visual information from the soap opera, presumably leading to a better developed semantic representation in this case. Now participants would watch two episodes a day for four days in order, as before. Participants would be tested on both cross-domain and within-domain self-priming blocks of trials regularly throughout the learning period. I would predict an interaction between prime type (related or unrelated) and the group a participant is in (visual or audiovisual), with more priming being observed in the audiovisual condition. It would also be most interesting to compare perceptual processing for these two groups of participants: does the well-formed semantic representation in the audiovisual group lead to improved perceptual processing? The design, furthermore, would allow one to estimate the contribution that visual co-occurrence makes to any priming effect by simply comparing the magnitude of priming observed for the two groups at each point of testing. The visual group should become sensitive to such visual co-occurrence without the effect being entangled very much with semantic knowledge whereas the audiovisual group will also be exposed to the visual co-occurrence structure but any effect will be entangled with much semantic knowledge.

Thus an experiment like the one just outlined could demonstrate some important points about familiarisation. Although such an experiment would be costly to conduct a comparative wealth of information could be obtained in return. Information from a feature generation study on the soap opera characters would also be very useful in terms of predicting the effects seen in priming or verification tasks. The soap opera methodology could further be used to study the effects of semantic knowledge on simple recognition memory tasks, an important question in its own right.

In summary, I have presented several potential experiments and lines of research where I think future work should focus. These suggested methods have a large potential to answer some interesting questions about familiarisation and person recognition.

5.5 Person Familiarisation – Theoretical Development

In this final section I attempt to develop some theoretical ideas which should prove useful for delineating a model of person familiarisation inclusive of the processes of person recognition.

5.5.1 Perceptual Familiarisation

This section on perceptual familiarisation borrows heavily on the ideas outlined in the discussion sections throughout chapter four of the present thesis. On McLelland & Chappell's (1998) view each item experienced would be represented by means of a vector; the representation would be initially noisy and generic but becomes, with experience, differentiated (McLelland & Chappell, 1998). On repetitions of the same item (a face say) the same vector representation would be activated with a certain probability. McClelland and Chappell view this detector selection process as occurring via a likelihood decision, and hence sometimes it will be wrong and lead to either the creation of a new detector or the storage of the present information with another item's detector (see also Shiffrin & Steyvers, 1997). It is the process of differentiation, moreover, which leads to the increases in accuracy which appear over the course of a learning period, and the decrease in the probability of false positives. That is, initially a detector forms noisy estimates for a given item but with repetition of that item the detector's representation becomes more and more refined. Each subsequent repetition, however, results in a smaller effect of learning. Thus the relation between repetition and accuracy is not linear over the whole scale, rather it would be a power function or an exponential function with an initial period of rapid improvement followed by subsequent decrease in the effect of each repetition. As outlined in chapter four of the present thesis this model can account for the performance on accuracy observed for the newly learned items relative to the famous items over the course of learning. This model would also seem able to account, for the effects of learning observed in chapter three (Experiment 3B) of the present thesis for the soap opera characters (briefly, a decrease in the probability of making a misattribution along with an increased probability of making a correct name response as the learning period progresses).[75]

The decrease in response latencies, moreover, over the learning period would seem to reflect the common finding that almost any task is done faster with more experience of that task (e.g. Logan, 1988). Logan (1988; 1992) explains the increased speed as a function of the number of traces one has in memory of doing the task. One will be faster the more traces there are in memory of processing the relevant set of items. Thus processing of newly learned faces will decrease in latency with more experience of processing those faces as more experience means more traces of a given item. This is exactly what is provided by the learning period in Experiments 4A and 4B. Thus the general finding of latency speed-up observed for the newly learned faces relative to the famous faces in chapter four can be explained due to a model such as Logan's. [76]

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[75] One would expect the model also to be able to account for the decrease in the probability of making a miss as learning increases in Experiment 3B.

[76] The model does not account, however, for why the Day by Person Type interaction is different across the two types of self-priming experiment (4A and 4B). In Experiment 4B, by day three performance on latency is statistically equivalent across the famous and newly learned items whereas for Experiment 4A there is still a significant difference. What Logan's model can account for, however, is the disproportionate decrease in the response latencies to the newly learned as opposed to the famous items as the learning period progresses. This shows through strongly on both experiments and is the principal finding here.

Of course, one would like ideally to be able to derive a unified model which can account for both phenomena. That is, the model of McClelland and Chappell performs in an excellent manner with respect to accounting for accuracy changes accompanying learning whereas Logan's model does likewise for latency changes. Unfortunately neither, at present, does both. The two models, as mentioned earlier, are somewhat contradictory in the sense that the former utilises abstract representations (detectors) whereas the latter uses multiple trace representation. Is there an extant model which can account for both performance on both dependent measures?

The theories put forth by Anderson (1990; Anderson & Schooler, 2000; Anderson & Milson, 1989) and Logan (2002), may be able to explain both aspects of the perceptual familiarisation data reported in the present thesis. Anderson's rational analysis of human memory (e.g. Anderson & Schooler, 2000) can certainly predict that both probability and accuracy of *recall* are power functions of repetition.[77] The problem here, however, is that the relevant data reported in this thesis are obtained in recognition tasks. Recall and recognition, it is known, are not necessarily achieved by the same processes and as such one cannot just assume that effects which hold for probability and accuracy of recall are necessarily isomorphic for recognition. If Anderson's analysis can be extended to recognition and produce the same functions then that would be enough to account for the results reported here in one unified theory. Whether this can be achieved is, at present, an open question. Logan's (2002) theory, further, can account for aspects of attention, categorisation and memory and as such it seems a good candidate. It certainly deals with recognition (categorisation), and it certainly deals with both accuracy and latency measures (as does Anderson's rational analysis). Simulations demonstrate that latencies speed-up as a power function of repetition. It is unclear, however, whether this extends to accuracy performance. Logan (2002) notes that accuracy improves with practice but the details of how his model's account of the improvement would apply to the present data are not clear. Thus while both of the theories considered here have the potential to account for the results on

[77] I am missing out a step here. Need probability, a quantity reflecting how much a given memory is needed in a given situation on Anderson's view, increases as a power function of repetition, and in turn accuracy and probability of recall are power functions of need probability (see Anderson & Schooler, 2000).

perceptual familiarisation for both dependent measures in a single unified model it is unclear at present whether they can actually do so. More work is required to investigate the matter further.

5.5.2 Semantic Familiarisation

Perceptual familiarisation, on the one hand, focuses on how our perceptual representations change with experience (e.g. our representations of someone's face and voice, for instance). The processes of semantic familiarisation, however, are concerned with how we learn semantic knowledge from perceptual experience. I noted earlier that the models which can account for aspects of perceptual familiarisation do not speak to the processes of semantic learning per se. There is at least one model, however, which does attempt to account for semantic learning, at least for objects.

5.5.2.1 The model of Rogers et al. (2004a)

A recent model by Rogers et al. (2004a) deals explicitly with the patterns of performance observed in patients with semantic dementia. It also, moreover, is explicit about how semantic knowledge is acquired. The authors propose, following Wenicke, that "semantic knowledge emerges from the interactive activation of modality-specific perceptual representations of objects and statements about objects" (2004a: 2). Thus semantic knowledge is taken to arise out of the links between modality-specific representations for an object, that is, the representation for each object via the different possible modalities of representation (e.g. the concept *rose* consists of a "visual image", a "tactile image", an "auditory image" and so on. Example from Wenicke, cited in Rogers et al.)

Rogers et al.'s distributed connectionist model consists of three pools of units. There is a verbal attribute pool which consists of verbal features of objects (things like names, functional properties, encyclopaedic properties, and visual properties). This pool represents verbal descriptions of objects. There is also a visual attribute pool which consists of visual features of objects (e.g. "is round"). This pool codes visual representations of objects (high-level visual representations). Thus a verbal representation for an object consists of a pattern of activation across the verbal attribute pool and similarly a visual representation for an object consists in a pattern of activation across the visual attribute pool. Perceptual information is provided as external signals to each of these pools of units. The third pool of units comprise the semantic system. This pool receives no external input; rather input is given solely from previous activity within the verbal and visual pools. All of the units in each of the input pools are bi-directionally connected to the units in the semantic system but units in the different input pools are not linked to one another directly.

To present an object to the network, the units representing that object within either the visual or the verbal pool are *clamped* at on and the other units within that pool turned off. The task of the model is then to generate the appropriate set of response properties for that input. Thus the units in the visual pool representing a *zebra* could be clamped at on, and the remainder turned off. The model then has to activate the correct verbal descriptors for the visual input of *zebra*. Or this could be reversed: the verbal units representing a *zebra* could be clamped at on, and the task would then be for the model to activate the correct visual units for that input (other permutations are also possible such as activating only some verbal units for a given item – e.g. only activating the name unit, or the other verbal descriptors etc). Thus one major advantage of this model is that various tasks can be explained within it (e.g. picture naming, naming to definition, and property verification to name a few).

It is important to note that the semantic system on this view has no semantic content – the content is within the perceptual-motor regions of the brain which encode the aspects of experience (cp. Damasio, 1989). Thus semantic knowledge does not consist of a set of features for a given item, rather semantic knowledge is a mapping between different perceptual systems. This contrasts with standard models of semantic representation (e.g. McRae et al., 1997; Masson, 1995; Collins & Quillian, 1969). The semantic system is, however, structured. Indeed Rogers et al. show how the similarity structure which emerges from the semantic system in their model is different from both the similarity structure observed for the verbal attribute representations and for that seen in the visual attribute representations. Rogers et al. take this to be a fundamental point: that the structure of the semantic system generalises, in a sense, over the structure apparent in each input domain. The semantic system's function then, is to map an input object (be it a name, verbal description or visual description) to some response properties (be they a name, verbal descriptors or visual descriptors). Rogers et al. comment, moreover, that the weights of the model store the model's semantic knowledge.

The important point to consider here, however, is how the model learns semantic structure. I will then, in the next section, consider the model's applicability to the processes of person familiarisation. Learning occurs as follows (Rogers et al., p4): an input is presented to the model for some time period and then activation is allowed to flow around the system. The input is then terminated and once again activation is allowed to flow. Next, the difference between the actual values of units in the visual and verbal pools and the desired values of those units is computed. Finally, the weights between all units are modified by some small amount to diminish this difference. Rogers et al. argue that this training regime can be seen as being analogous to what happens when a child learns semantic knowledge. They give the example of a mother asking her child to "Show me the piggie" in a picture book where the mother will give feedback on what is the correct picture if the child is wrong. This last step is taken to be analogous to the step in learning where the actual states of units in the visible units are compared to the desired states and adjusted (to model the feedback the child receives).

The model uses a variant, moreover, of the backpropagation learning rule which has been noted for its biological implausibility. Another point of criticism, moreover, is that the model is not actually trained on norm data; rather just on representations which attempted to capture the structure present in the norm data. Thus, in summary, although there are a few problematical issues with this model it specifies in detail the semantic acquisition process. Further, although I will not review the explanations here the model accounts well for the performance of semantic dementia patients on a wide range of tasks. The specification of semantic acquisition is the most interesting aspect of the model for the present concern.

5.5.2.2 Applicability to Person Familiarisation

At a more abstract level one can think of Rogers et al's model as consisting of the following: a perceptual input space for each modality (e.g. auditory, visual, proprioception, emotional state etc) and a unitary semantic space. What the semantic system does is link the relevant representations in each input space as a function of the co-occurrence structure of the environment.

With respect to person familiarisation, one could imagine designing an analogous model to that of Rogers et al. The model would be trained to associate certain verbal descriptions of people (e.g. their name, and other verbal properties) with visual representations of people (e.g. their face and name). The verbal descriptions of people, moreover, could be obtained from property generation tasks although the visual descriptions for faces (and names) would not be collectable in the same manner as used by Rogers et al. One would have to obtain a compressed representation for each face (something like PCA perhaps). Training would lead, presumably, to a state where one could probe the system with a person-specific stimulus (such as a face, name, or verbal description) and have the semantic system generate the correct response properties (such as name, verbal description, face etc). Thus this system would be able to learn, in some fashion, about new people in a semantic manner.

Would it, however, provide an explanation of the semantic findings from the present thesis and furthermore, the semantic tasks normally used in person recognition? Taking the latter point first, one would think such a model could account for associative / semantic priming effects since the difference (in terms of similarity) in the semantic representations for two items could be used to predict priming for such items. One would expect such a model to be able to deal with both within-domain and cross-domain associative priming, and furthermore self-priming. These are just speculations, however, which require to be corroborated. With respect to the data from the present thesis, the model could probably account for the advent of self-priming effects with learning (Chapter 4), and further for the fact that the co-occurrence structure of the environment determines responses on verification and recall tasks (Chapter 3). It is harder to see how such a model could account for the main result from the first experimental chapter (Chapter 2) where the processing of expectancy congruent material is facilitated after an initial learning period. One would think that, however, given these types of models' ability for generalisation (see McClelland & Rogers, 2003)[78] that by teaching the model with a given type of face (male or female) and certain descriptive properties (e.g. works in hospital, likes to keep patients well) the model could generalise the correct occupational property (e.g. doctor or nurse). For this to work, the model would already have to been trained with many male and female faces and the relevant occupations (names plus features). Thus there may be a mechanism here which can account for the benefit seen for the implied occupation in the experiments reported in chapter two. Thus on a first pass, this model of Rogers et al. may in principle be able to account for several of semantic effects in person recognition and person familiarisation. More work is required, however, to actually move beyond in principle arguments to demonstrations of the relevant phenomena.

A critical point, in any event, is whether Rogers et al.'s system learns in a way which is comparable to how adults learn about new people. While a child is learning about objects it seems quite plausible, intuitively, that the way the child learns semantic knowledge about such objects may well be aided by an external source providing corrections (e.g. a mother or a teacher, for instance). Thus the learning regime in Rogers et al.'s model seems reasonable in this light. For an adult learning about new people, however, this type of training seems less plausible. While learning may sometimes be guided by an external source providing corrections it would seem to be less pervasive here. A second point is that with new person learning (or with new learning of other types of unique entity such as buildings) the demands on the learning system are different than for learning about generic objects, which is what Rogers et al.'s model deals with. Thus these are two important differences between the case of new person learning and more generic new object learning.

The first point I have raised here would seem to question the suitability of applying the learning procedure utilised by Rogers et al. to new person learning. In addition, ideally one wants the mechanisms of normal processing and those of learning

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[78] The case here is analogous to McClelland and Rogers (2003) considering generalisation in a model of Rumelhart's. Simply put, by training the model on a set of animals and their features, one can then train the model on a new animal (e.g. sparrow) and a subset of features (is a bird, animal, living thing), and the subsequent responses generated for this new animal will be similar to that formed for other comparable animals (e.g. other types of bird). The system will generate *can fly*, *has wings* for the sparrow as input.

to be tightly coupled. Indeed it has been argued that mechanisms of learning may well be the same mechanisms responsible for normal processing (Bowers & Kouider, 2003). These ideals are not achieved by Rogers et al.'s model. The second point highlights one of the important differences between new person learning (really any form of unique identity object learning) and generic object learning. Evidence reviewed in the introductory chapter on neuropsychology, moreover, highlighted that the processing / representation of unique objects is partially independent to that of generic processing / representation of objects. Thus we have no reason to expect the same mode of representation or of learning, necessarily. With these considerations in mind is there still something here from which a model of new person learning can be gleaned?

There are certainly some insights in Rogers et al.'s model. First, the notion of the semantic system not bearing any semantic content itself and rather just being a linking system seems worth exploration. That is, the notion of semantic knowledge as a process and not a knowledge store (Rogers et al., 2004a: 34). Second, the ability of their model to simulate a multitude of tasks in various input / output modalities is impressive. Many models lack the ability to simulate such a range of tasks but task generalisation is critical for theoretical generalisation.

In conclusion then, I think that the model of Rogers et al. has many important insights for researchers intent on developing a model of the semantic aspects of new person learning. At present, however, I do not think that the mechanisms of that model can just be applied to person recognition to yield the required results given the possible problems with the learning mechanism employed. There is also a great need to demonstrate that the *in principle* arguments which I have made actually hold in an implemented model. More work is needed to delineate the processes involved in new person learning, and more generally the learning of unique identity objects.

5.5.3 An Inference Generator

I take an inference generator to be an integral part of the human memory system and not anything separate. Simply, given attention to a set of probes, information will be retrieved from memory dependent on the probe set (see e.g. Logan, 1988). This information can henceforth also be represented in memory if attended too (alongside perhaps some stimulus information present in the external environment). Thus inference generation is nothing special on this view, rather just a part of the normal functioning of the human memory system. Some way of including these processes will need to be found in any complete model of familiarisation.

5.5.4 Putting It All Together

At present the mechanisms which I have specified in the present chapter, especially those in the preceding sections on perceptual familiarisation and semantic familiarisation could, in principle, account for many of the standard results in person recognition (such as repetition priming and associative priming) in addition to the results on familiarisation which they were initially recruited to explain. One result at least, however, remains problematical. This is the finding of cross-domain repetition priming (Burton, Bruce, & Kelly, 1998). Simply put, repetition priming across stimulus domains (e.g. face at prime to name at test) is found if a semantic decision task is used at prime and test but not if a familiarity decision is used. This would not seem to find an easy explanation in any of the models I have used to explain aspects of familiarisation. The key to explaining this effect, of course, is the link between the perceptual processing aspects of a theory and the semantic processing aspects of the theory, and it has to be acknowledged that I cannot, at present, link the different explanations I have used throughout this thesis into one unitary model.

An integrated theory of person recognition, inclusive of person familiarisation is thus still some way off at present. I have identified, however, plausible mechanisms for different components of the familiarisation process (e.g. perceptual familiarisation as measured by latency and accuracy and aspects of semantic familiarisation) so that the task remaining is to attempt to integrate these components (or performance equivalent mechanisms).

5.5.5 Implications for IAC models of familiar person recognition

Some implications for IAC type models from the present discussion are readily apparent: first, such steady state models need to specify where the semantic structure present in those models arises from – to date it seems to be hand-wired (see also Rogers et al., 2004a). Such models, further, must be refined to incorporate the processes of new learning or else they will be of little use in building a full spectrum theory of person processing. Moreover, unless such models are refined then they are of little use in attempting to explain processes of familiarisation.

A related point is that the semantic structure present in a model such as that of Rogers et al. is a direct consequence of the structure garnered from earlier property generation studies (see also e.g. McRae et al., 1997). Although such models have not yet reached the stage when the representations derived from the generation studies can be implemented directly into the model at least the representations of the model are constrained by what is present in the property generation data. Thus one possible mode of advance for IAC type models would be to structure the semantic representations dependent on property generation studies. This, at least, removes some degrees of freedom in the specification of semantic representations. If one, however, just specifies semantic representations even according to such norms one misses out the whole process of how semantic knowledge is derived from perceptual experience (see Rogers et al., 2004a). Thus one would not be dealing with the issue of familiarisation. An improved method would be to conduct property generation studies, at appropriate time points during learning, and try to map the development of semantic structure. If such development could be tied in with the development of associative and semantic priming effects this would certainly represent an advance. (Another improved method would be to follow the approach of Rogers et al. and train the model, in some manner consistent with new person learning, on the structure present in the norm data.)

One more implication for IAC models from models such as Rogers et al. and McRae et al. is that if the semantic structure present in a model is not hand wired (i.e. if it is constrained by property generation data) then detailed predictions about the magnitude of priming (between any given two items) should be possible on semantic tasks. This would presumably allow for a closer correspondence between the model's predictions and the observed data since the model's representations will be more finely grained.

As mentioned earlier, one must consider the importance of giving due respect to the processes of new learning when building a steady state model: namely, that the processes involved in new learning may be the same processes that subserve normal processing, to a large extent. Thus there are powerful reasons for IAC theorists of person recognition to extend the explanatory content of their models to include new person learning.

5.5.6 More Implications for Future Research

In this section I will outline some important questions for future research to focus on as a consequence of the Rogers et al. (2004a) model of semantic structure. Before doing so, however, I will summarise some key properties of their model which reflect the performance seen in the semantic dementia patients. Since the model was developed to account for patterns of impairment observed in semantic dementia the focus of Rogers et al. is on how the model, when lesioned, accounts for patient performance. Several key properties of the model emerge from these considerations: most importantly, as damage accumulates the ability to maintain fine distinctions between semantically similar objects is lost. First, the propensity of making different types of error in a confrontation naming task differs due to semantic domain (living things Vs artifacts). Commission errors are more likely for dense regions of semantic space (living things in this model) while omission errors are more likely for sparse regions of semantic space (artifacts here). This is due to the fact that in dense regions of semantic space it is quite *easy* for one semantic representation (attractor), when damaged, to fall into a neighbouring attractor. On sorting tasks the authors report better sorting for general than specific categories and this results from that fact that attributes of a broad semantic category are shared across many members and hence are quite redundantly represented. In word-picture matching tasks, moreover, performance is better when the distracter item is semantically distant rather than close, for the same reasons as outlined above. Finally, the authors also considered a drawing task. More intrusions (adding in incorrect feature; e.g. four legs for a swan) were found to be made for the animal domain than for the artifact domain. Features shared across the semantic domain were least likely to be omitted but most likely to cause an intrusion error (the reverse is true of idiosyncratic features). These properties are present both in the patient data and the model – making the model a good explanation of the impairment observed in semantic dementia.

Rogers, Hodges, Lambon Ralph, and Patterson (2003; Rogers, Lambon Ralph, Hodges & Patterson, 2004b) have further shown that performance on both lexical decision and object decision in semantic dementia is influenced by the typicality of the words / non-words and the real / unreal objects, respectively. In both instances, the task consists, on each trial, of deciding which of two simultaneously presented stimuli is real (one is always real, the other unreal). On some trials the real item is the more typical of the pair whereas on other trials the unreal item is the more typical of the pair (typicality is manipulated by altering bigram and trigram frequency in lexical decision and the amount of shared across domain features in object decision, respectively). The critical finding is that, when the items are low in familiarity (frequency for words) and impairment is severe, patients select the more typical items as being the real items regardless of whether the item is actually real or not – and thus they perform well when the real item is the more typical of a pair but poorly when the unreal item is the more typical. Thus it seems that such typicality, in these conditions, drives patients' performance on these tasks. The authors predicted just this pattern of performance in both lexical decision and object decision on the basis of the model outlined earlier (Rogers et al., 2004a). Once more, the key factor is that, with impairment, patients lose the ability to distinguish between similar objects but still have knowledge as to the properties which distinguish broad categories (the typical features of a domain).

Rogers et al. (2004b) also argue forcefully that such results, in the object domain, suggest that the semantic system is not independent of stored structural representations (visual) or else the patients should be able to perform accurately on object decision regardless of the manipulated type of typicality (assuming visual perception is normal in such patients which it seems to be).

One prediction from the model of Rogers et al., with respect to person processing, concerns the patterns of impairment likely to be seen in neuropsychological disorders of the semantic aspects of person processing. Specifically, this model would suggest, if we assume a comparable model of semantic space for persons, that type of error (commission or omission) on naming tasks should be related to the density of semantic space for each class of persons considered – with more commission errors for denser regions and more omission errors for sparser regions of the space. It has to be acknowledged, however, that I do not know exactly which level this effect would manifest itself as related to persons (and not objects). Perhaps it would occur at a famous person versus personally familiar level, or rather within subclasses of these broader categories of person. Property generation studies would have to be carried out with each main class of person to aid in prediction here. If famous persons and personally familiar persons form distinct regions within semantic space then patients should not misrecognise a member of one class as being from the other unless impairment is very severe. Since the structure of semantic space determines modelling of all the tasks considered by Rogers et al. similar properties of that space would influence analogous tasks for someone with brain damage to the semantic aspects of person processing (e.g. name-face matching tasks and sorting tasks).

A second prediction is tentative at the moment but may well demonstrate some interesting properties of a model such as Rogers et al.'s. Briefly, in their model the structure of semantic space is determined by the structure of the information in the input modalities (visual and verbal attributes of objects). This suggests that if we block off a given input channel then we should be able to modify the structure of semantic space and hence modify participants' responses on semantic tasks (since these reflect the structure of semantic space). Moreover, the model's semantic representations in each case (i.e. with different inputs blocked off) predict participant performance. Thus if such an experiment were carried out and predictions were upheld this would be strong support for the extraction of semantic structure from input domains in an analogous manner to that performed by the Rogers et al. model. This idea would be most interesting to apply to new person learning with the soap opera materials since here we could easily block off different input channels (visual and auditory). Thus, in addition to being a test of the Rogers et al. model this type of experiment would tell us much about the semantic aspects of new person learning, surely a course worth pursuing.

Thus, in summary, I have reviewed several key properties of the model of Rogers et al. (2004a) critical in explaining performance seen in semantic dementia patients. I, furthermore, have suggested some areas where the Rogers et al. model makes predictions in the field of person processing (given some simple assumptions).

5.5.7 A Distant Goal

The goal, as I see it for researchers in person familiarisation, is to generate a model which can somehow view the soap opera episodes (used throughout the present thesis) and create and modify relevant representations and show the same phenomena which participants show in learning experiments. In a similar way to how Burgess and colleagues have trained their model on a natural corpus of text (see e.g. Burgess, 1998), the ideal person familiarisation model would be trained on the soap opera. This is, however, far too ambitious at the moment. What one could do, however, would be to train a model with analogues to the structure present in the soap opera.

Could a model, for instance, trained simply on co-occurrence structure display the normal effects we expect for newly learned people at appropriate time points during learning? I am using co-occurrence here in a multi-sense fashion so let me explain. First, there is co-occurrence between objects in the environment – take visual co-occurrence – thus some characters tend to appear on-screen together. There is also auditory co-occurrence, for instance, some people's voices may occur together. These are both examples of single stream co-occurrence. Second, there is auditory-visual co-occurrence. There is structure in how certain kinds of visual objects appear with certain kinds of sounds and any model would have to be able to extract this structure from the soap opera (e.g. the link between a person's visual appearance and their voice). Objective measures of visual co-occurrence could be obtained relatively easily (e.g. which characters are on-screen together in each time window). Objective measures of auditory co-occurrence could also be obtained by considering which characters co-occur across a suitable time-window. Audiovisual co-occurrence could likewise be noted in this manner (which faces appear with which voices etc).

There is also the co-occurrence of features across characters in the soap opera, and more generally, across people. Two characters in the soap opera might both work at the garage though in different roles, for example. This type of structure is presumably important in specifying person-specific knowledge representation. This type of knowledge would have to be obtained from participants at each stage of testing in property generation studies and then represented for use in the model. I don't think any model would be able to extract this type of information from the soap opera at present.

Thus I think there is a research project here which may well be able to explain the structure of participants' responses on a given task at each stage of learning by the structure of the learning environment which they are exposed to (along with some considerations of general person-specific knowledge representation).

I propose two steps to the goal outlined at the beginning of this section. The first step is to show how the structure of the soap opera determines participants' responses on various tasks throughout learning and to demonstrate this in an implemented model. The second would be to investigate how participants actually extract the relevant structure from their environment and attempt to incorporate this behaviour into a model.

5.6 Conclusion

In summary, the present thesis has provided data with which to constrain future models of full-spectrum person recognition, especially with regards to semantic familiarisation. I have, furthermore, suggested several future lines of research which may well progress research in this field. In addition, I attempted to derive theoretical explanations for the various phenomena explored in the present thesis. Although I have not been able to specify a single theory to account for the data presented within this thesis, and the existing phenomena of person recognition, I have identified plausible mechanisms that such a theory may do well to implement. Finally, I suggested a goal for researchers working on person familiarisation and on the inclusion of that process into models of full-spectrum person recognition.

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Appendices

Appendix 2A- The Scenarios from the Learning Phase of Experiments 2A and 2B (with version two information in parentheses)[79]

Pilot/Air Hostess (Air Steward)

→ Jane (Andrew) lives in Ayr.
→ She (He) flies long hours most days.
→ She (He) has travelled all over the world with her (his) job.
→ Jane (Andrew) is married with two children.

Doctor/Nurse

→ John (Kate) lives in Birmingham
→ He (She) works at the local hospital.
→ He (She) likes to keep his (her) patients well.
→ John (Kate) has just become engaged to his girlfriend (boyfriend).

Chef/Waitress (Waiter)

→ Paul (Denise) lives in Manchester.
→ He (She) works in a gourmet restaurant.
→ The customers expect standards to be exquisite.
→ Paul (Denise) has one teenage daughter.

[79] Experiment 1B uses a different allocation of faces and names to scenarios than that above.

Secretary/Technician

→ Kate (Paul) lives in Bristol.
→ She (He) works in the biology department at the local university.
→ She (He) is a non-academic member of staff who assists the lecturers in their work.
→ Kate (Paul) has four brothers.

Jockey/Showjumper

→ Andrew (Jane) lives in Sussex.
→ He (She) is a professional sportsman (sportswoman).
→ Both he (she) and his (her) horses train hard most weeks of the year.
→ Andrew (Kate) likes reading mystery novels in his (her) free time.

Cleaner/Janitor

→ Denise (John) lives in Glasgow.
→ She (He) must keep the school tidy.
→ The children are forever giving her (him) more to do.
→ Denise (John) married a number of years ago.

Appendix 2B – Table of individual item median response latency and mean percentage correct for Experiment 2A

Appendix Table 1: Median Response Latency (ms) and Mean Percentage Correct for each 'True' statement of the verification task in Experiment 1A.

Statement	Median RL (ms)		Mean PC	
V1 item (GC / GI) (SEX)	GC	GI	GC	GI
Cleaner / Janitor (F)	1440	1612	100	100
Secretary / Technician (F)	3096	1908	80	90
Air-Hostess / Pilot (F)	1427	1860	100	100
Chef / Waiter (M)	1633	1360	90	100
Jockey / Show-jumper (M)	1376	1488	100	100
Doctor / Nurse (M)	1218	1466	100	100
Mean	1698	1616	95	98.33
V2 item (GC / GI) (SEX)	GC	GI	GC	GI
Waitress / Chef (F)	1201	1486	100	100
Nurse / Doctor (F)	1159	1176	100	80
Show-jumper / Jockey (F)	1128	1243	100	100
Technician / Secretary (M)	1442	2501	100	70
Pilot / Air-Steward (M)	1308	1533	100	100
Janitor / Cleaner (M)	1156	1158	100	100
Mean	1232	1516	100	91.67

Appendix 3A – List of Semantic Probes used in Experiment 3A

Name	Semantic Probe
Bill Clinton	the person who was the last president of the USA
Boris Yeltsin	the person who was the last president of Russia
David Beckham	the person who is married to Posh Spice
Denise Lewis	the British athlete who won gold in the heptathlon at the 2000 Olympics
Michael Caine	the person who is the English star of the film *The Italian Job*
Mel Gibson	the person who is the Australian star of the film *Braveheart*
Ronan Keating	the person who is the lead singer of "Boyzone"
William Hague	the person who is the current leader of the Conservative party
Andre Agassi	the American tennis player whose current partner is Steffi Graf
Britney Spears	the young American singer whose hits include "Baby hit me one more tim
Kylie Minogue	the person who sang a duet with Jason Donovan titled "Especially for you
Kate Winslet	the person who is the female star of the film *Titanic*
Margaret Thatcher	the person who was the only female British Prime Minister
Sean Connery	the person who was the original 007
Steve Redgrave	the British rower who won gold at the 2000 Olympics
Tony Blair	the person who is the current British Prime Minister
Brad Pitt	the person whose current partner is Jennifer Anniston
George W Bush	the person who is the current President of the USA
John Lennon	the member of the "Beatles" who was shot dead
Lennox Lewis	the British sportsperson who was recently world heavyweight boxing champion
Noel Gallacher	the person who is the lead guitarist for Oasis
Nicole Kidman	the person who recently split from Tom Cruise
Robbie Williams	the person who used to be a member of "Take That" and is currently a successful solo artist
Tiger Woods	the person who is a famous black golfer

Appendix 3B – List of Semantic Probes used in Experiment 3B

Character Name	Semantic Probe
Rita	the person whose boyfriend is Frank
Noleen	the person who is engaged to Martin
Nicola	the person who use to be married to Paul
Jimmy	the person who was Lorraine's boyfriend some time ago
Dolores	the person who is married to Harry
Paul	the person whose current partner is Helen
Lorraine	the person who was engaged to Jack
Helen	the person who is Rachel's mother
Bela	the person who has money problems
Harry	the person who owns the garage
Jack	the person who is a doctor
Dermot	the person who was elected to the council

Appendix 3C – Occupational and Relational 'true' statements used in Experiment 3C

Name	**Relational**	**Occupational**
Tony Blair	has a son	is Prime Minister
George Bush	has children	is President
David Beckham	is married	is a footballer
Tom Cruise	split-up from wife	is an actor
Michael Jackson	has a daughter	is a singer
Kate Winslet	has a kid	works in films
Bill Connolly	has a wife	is a comedian
Margaret Thatcher	has a husband	is retired
Janet Jackson	has siblings	is a musician
Anna Kournikova	has a boyfriend	is a tennis player

Appendix Table 2: Mean word count and letter count (in parentheses) for the statements in each condition for Experiment 3C. I note that given these values alone if anything one would expect faster processing of the relational information.

	Relational	Occupational
True	2.80 (10.4)	2.90 (11.5)
False	2.60 (10.8)	3.10 (11.5)

Appendix 3D – Occupational and Relational 'true' statements used in Experiment 3D

Name	Relational	Occupational
Harry	is married	runs the garage
Lorraine	was engaged	was a waitress
Bela	is now divorced	works with furniture
Rita	has a new boyfriend	was a shopkeeper
Jimmy	has siblings	is a mechanic
Dermot	has a girlfriend	is an accountant
Paul	has a daughter	is a businessman
Nicola	has a young baby boy	works in a company
Jack	split-up with partner	is a doctor
Dolores	has a husband	is a housewife

Appendix Table 3: Mean word count and letter count (in parentheses) for the statements in each condition for Experiment 3D.

	Relational	Occupational
True	3.10 (13.0)	3.11 (13.2)
False	3.20 (13.3)	3.30 (13.2)