Effects of Conceptual Processing on Recognition and Conceptual Priming

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By

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Abstract

The depth of encoding processes has been a variable of great importance in the study of the conscious correlates of memory. The presence of depth-of-processing effects in an intentional (direct or explicit) memory test has been interpreted as a marker of the engagement of *voluntary* retrieval associated with conscious recollection of the study episode. The absence of such effects in an incidental (indirect or implicit) memory test, where memory for previously encountered material is expressed as priming, has been interpreted as the marker of a form of *involuntary* retrieval. A problem arises in conceptual incidental tests, where priming is guided by a conceptual connection between the retrieval cue and the target memory, rather than by a perceptual connection. Depth-of-processing effects are usually reported in conceptual priming. The presence of such effects in conceptual priming creates problems for theories of the conscious correlates of memory in two main respects. In one respect, it is argued that dissociations between intentional and perceptual incidental tests are not due to the tests tapping voluntary and involuntary memory respectively, otherwise depth-of-processing effects would be absent in conceptual priming as well. The logic of this argument implies that the voluntary/involuntary dimension of memory is not an appropriate theoretical construct to explain the dissociations. In the second respect, depth-of-processing effects in priming have been interpreted as the results of contamination from a voluntary retrieval strategy and therefore they do not reflect involuntary memory. However, there are a small number of reports of an absence of depth-of-processing effects in conceptual incidental tests that undermine the arguments proposed above. In this thesis, the aim was to identify the circumstances under which depth-of-processing effects occur in conceptual incidental tests. Firstly, following Toth's (1996) suggestion that familiarity in recognition memory is mediated by the same processes that mediate conceptual priming, the effects of depth-of-processing were investigated upon measures of familiarity. In Toth's (1996) study, a speeded response procedure, designed to capture familiarity based responses, revealed an effect of depth of processing on familiarity, as in conceptual priming. Toth's findings were replicated, but "Know" responses, collected in conjunction with the speeded responses, were found *not* to be susceptible to depth-of-processing effects. The implications of this finding are discussed. Depth-of-processing effects in conceptual incidental tests of word association were investigated next. In six different conditions, a dissociation was replicated between intentional tests and conceptual incidental tests following a manipulation of depth of processing at study. The manipulation had an effect on the retrieval of strong associates in the intentional test but not in the incidental test. This dissociation was replicated in older adults and was not an artefact of ceiling effects (as compound weak-associates did not show an effect of depth of processing) nor "response bias" (as this was equated between the two tests). A further experiment, in which study-test modality was manipulated, supported the hypothesis that the test tapped more conceptual processes. The absence of depth-of-processing effects could not be explained by this task tapping perceptual processes. The overall results make two major related points. Firstly, the dissociations support the idea that the involuntary/voluntary dichotomy in memory is still an important theoretical construct with explanatory power. Secondly, the dissociations go against the hypothesis that conceptual incidental tests are contaminated by voluntary retrieval strategies.

Chapter 1
Conceptual priming

Overview of Chapter 1

The chapter reviews the literature on conceptual priming, a putative form of involuntary memory that is conceptual (as opposed to perceptual) in nature, in the sense that the retrieval is guided by a conceptual connection between the retrieval cue and the target memory. This type of memory is hypothesised to be involuntary because the target memory can be retrieved unintentionally (and possibly without conscious awareness of the encoding episode) without reference to the study episode and the test is defined as *incidental* in respect to the study episode as opposed to *intentional*. One main issue that is further explored in this thesis is whether this form of priming constitutes a truly separate memory phenomenon from voluntary memory and hence whether it can be dissociated from it. There is some preliminary evidence in the literature that performance in conceptual-incidental tests can be dissociated from performance in intentional tests. Advocates of a non-unitary view of memory (e.g., Cermak, Verfaellie, & Chase, 1995; Schacter & Tulving, 1994; Tulving, 1999; Vaidya, Gabrieli, Keane, & Monti, 1995) suggest that separate systems with separate representations mediate separate memory functions. They propose the voluntary/involuntary (or explicit/implicit) distinction as a useful dichotomy to explain dissociations in performance between memory tasks: They propose, in very general terms, that priming and voluntary retrieval are mediated by two separate systems. However, the usefulness of the systems' perspective to explain dissociations has often been questioned by advocates who generally subscribe to a unitary view of memory and tend to emphasise the role of "processes" (e.g., Blaxton, 1989, 1992; Brunfaut & Dydewalle, 1996). Process theorists in particular argue that memory tapped by intentional tests shares common representations and processes as memory tapped by *conceptual*-incidental tests and therefore performance on the two tests should not dissociate. The conceptual/perceptual dichotomy is proposed as the alternative critical distinction that can account better for the observed dissociations in performance between *perceptual*-incidental tasks and intentional tasks. In this scenario the exploration of the nature of conceptual priming and the study of the conditions under which it can be dissociated from voluntary retrieval is crucial to the assessment of the relative merits of the two proposed dichotomies. In this thesis a literature review of conceptual priming studies will point towards the need for a better specification of the type of memory representations called upon by conceptual incidental tests and for a better specification of how these representations are modified during the study episode.

1.1 Conceptual Priming

In the 1980s memory research began to characterise two different means in which memory for prior experience can be accessed by observing the conscious correlates of memory. A record of past experience could be accessed *intentionally* in a *controlled* fashion and conscious awareness of the past would be a necessary correlate of successful retrieval. Alternatively, a record of past experience could be accessed *incidentally* in a more *automatic* fashion and conscious awareness of the past would not be a necessary requirement. Intentional (or direct/explicit) tests of memory, such as recall and recognition, require people to intentionally think back and remember an earlier experience. These tests can be characterised as demanding voluntary and conscious realisation. Intentional memory tests are contrasted to incidental memory tests where no explicit reference to the study episode has to be made. Incidental (or indirect/implicit) tests require participants to respond to test stimuli and memory for prior events is inferred from facilitation in resolving tasks following prior exposure to target stimuli. The form of memory tapped by incidental memory tests is referred to as priming and examples include *perceptual identification, word-stem completion* and *category-exemplar generation*. In general, these tests are considered to tap a form of unconscious memory; but a better description would be of these tests primarily tapping a form of *involuntary* memory that can be both conscious or unconscious (Richardson-Klavehn, Gardiner, & Java, 1996).

A theoretically important distinction (Roediger and McDermott, 1993) has more recently been outlined between two classes of incidental memory tests. Some tests are considered to rely more on perceptual processes and some other tests are considered to rely more on conceptual processes. In *perceptual* incidental tests participants try to resolve perceptually impoverished or degraded stimuli. Examples of this would be the word identification task or the word-stem completion task where a perceptually partial stimulus is presented and participants have to provide the completion of the stimulus that first comes to mind. Priming is observed when the completion of the partial stimulus is facilitated by the earlier processing of the word during the study episode. In contrast, *conceptual* incidental tests provide an intact test cue that bears a semantic or conceptual relation to a possible response and participants are asked to solve a semantic task by giving the first response that comes to mind. Priming is observed when the response to the cue is facilitated by earlier processing in the study phase.

Several incidental memory tests are now classified as conceptual tests (see Vaidya, Gabrieli, Keane, Monti, Gutierrez-Rivas, & Zarella, 1997) but the main and most studied ones are the word association task, the category-exemplar generation task and the general knowledge task. In the word association task, participants study pairs of words: the first word in the pair constitutes the cue word and the second word in the pair constitutes the target word. In the test phase, the participants see the cue word and are instructed to produce the first word that comes to mind that is associated to the cue word. Priming occurs when participants reproduce words as associates of the cue word from target words presented in the study phase more often than unstudied associates. In the category-exemplar generation task participants study a list of words that are exemplars of selected categories (e.g., *furniture*). At test participants are required to generate a number of exemplars of a given category. Priming occurs when studied exemplars are reproduced as instances of category members in larger number rather than unstudied exemplars. In the general knowledge task, in the test phase participants are required to answer general knowledge questions. The answers to some of the questions having been presented in the previous study phase. Priming occurs when studied answers are produced more often than unstudied answers.

1.2 Intentional and Incidental Task Dissociations

Extensive effort in memory research has been expended in dissociating voluntary and involuntary forms of memory. Attempts to obtain dissociations between retrieval performances are made in order to provide some evidence that the underlying cognitive mechanism relies on operations that are separable at some level. The logic of dissociation studies is to identify a variable that has an effect on performance in one task but an opposite or absent effect on performance in another task.

A number of variables have been found to dissociate voluntary retrieval from priming. Most notably, patients with some neurological dysfunction have been found to be selectively impaired in intentional tests with intact performance in incidental tests. For example, amnesic patients' performance on incidental tasks tends to be at comparable levels to control participants when they are considerably impaired in intentional tasks (e.g., Graf, Squire, & Mandler, 1984; Keane, Gabrieli, Monti, Fleischman, Cantor, & Noland, 1997; Vaidya et al., 1995; Warrington & Weiskrantz, 1968). Experimental variables have also been found to have an effect on performance in one type of test but the effect is absent in the other type of test. For example, the degree of conceptual elaboration has been found to have an effect on intentional tests but not on incidental tests (e.g., Jacoby & Dallas, 1981; Graf & Mandler, 1984; Roediger, Weldon, Stadler, & Riegler, 1992). Study-test modality shift have typically an effect on incidental tests but not on recall and recognition tests (e.g., Craik, Moscovitch, & McDowd, 1994).

Task dissociations have been used extensively to outline the nature and characteristics of the memory tapped by incidental tests and to identify the critical dimensions that may make priming a distinct phenomenon from intentional retrieval. However, task dissociations can be theoretically interpreted in several ways. Task dissociations can arise from the operations of different *systems* mediating specific functions; or they can arise from the operation of different types of *processes* selectively engaged; or they can arise from the reliance of the two performances on separate *representations*; or, yet again, they can also arise in the case of the recruitment of a mixture of same and separate *components* guided by task-demands. This number of possible theoretical interpretations of task dissociations, which are not necessarily mutually exclusive, provides a very fertile ground for the development of theories of memory function. The main level of debate has been between advocates of separate systems that mediate the two forms of retrieval and advocates of the recruitment of separate processes to explain dissociations.

The theories which attempt to explain the dissociation between retrieval in incidental and intentional tests are reviewed in a subsequent section. However, before turning to the review of such theories, there is an important issue that needs addressing if appropriate inferences were to be made about the dissociations between incidental and intentional tests. The issue has to do with the level of dependence between voluntary and involuntary retrieval, in the sense that incidental tests can be resolved with voluntary retrieval and therefore the tasks are not process pure (see Jacoby, Toth, & Yonelinas, 1993; Richardson-Klavehn & Bjork, 1988; Gardiner, 1988). The "retrieval intentionality criterion" (Schacter, Bowers, & Booker, 1989) and the process dissociation procedure (Jacoby, 1991) have been strategies that have been developed to attempt to better separate memory that is the result of involuntary retrieval and memory that is the result of voluntary retrieval. These are also briefly reviewed.

1.2.1 The Retrieval Intentionality Criterion

Schacter, Bowers, and Booker (1989) propose, in order to make appropriate inferences about intentional and incidental uses of memory, that all overt variables and conditions that affect participants during the study phase and the test phase should be identical. The only thing to vary should be the retrieval instructions given at the time of tests. In this way any difference obtained between the two tests can be attributed to the participant's *intention* to retrieve and not to any other difference between the tests. So, if a variable dissociates performance on the two tests by having an effect on one test but not on the other test and all the conditions between the tests are equated except retrieval instructions, then stronger inferences can be made about the separation of the operations that mediate performance in the two tests. This strategy of equating all the conditions between the tests except the retrieval instructions and of having a variable with a different effect on the tests is said to satisfy the *retrieval intentionality criterion* (Schacter et al., 1989).

The intentional counterparts of incidental conceptual tests have been devised in order to satisfy this criterion in studies of conceptual priming. For the free association task, the counterpart is an associate cued-recall task where an associate is presented as a cue to recall the target words from the studied word-pairs. The category-exemplar generation task is compared with a category cued-recall task whereby a category name is presented and participants are instructed to use the name as a cue to remember words from the study list. In the general knowledge cued-recall test the questions are used as a cue to recall studied words.

1.2.2 The Process Dissociation Procedure

A second procedure that has been developed in order to separate voluntary from involuntary retrieval by tackling the issue of contamination, is the process dissociation procedure (PDP) proposed by Jacoby (1991). The proclaimed advantage of this procedure over the one reported above is that it deals with those situations when a variable is found to have a parallel effect on the two tests (but see Richardson-Klavehn, Clarke, & Gardiner, 1999). The assumption of this procedure is that incidental or automatic retrieval processes and intentional or controlled retrieval processes work in concert under direct or indirect retrieval conditions. To separate these processes, the strategy is to put them in opposition within one task. The rational of the PDP is that, during the completion of a given task, participants are explicitly instructed to avoid using material in the solution of a task that they can consciously recollect having come across in the earlier study phase. In this manner, should participants unwittingly produce earlier studied information, the retrieval of such information can be considered automatic and unconscious.

Although the PDP attempts to eliminate problems of dependency between voluntary and involuntary retrieval, it is also very limited as several assumptions are made about the relation between retrieval volition and conscious awareness that are not well supported. The issue surrounding the relationship between volition and consciousness is addressed in the following section.

1.2.3 Retrieval Volition and Consciousness

The assumption of the PDP is that phenomenal awareness in the task can be divided into two states of conscious awareness during retrieval. In one state, participants voluntarily retrieve the information through controlled processes and they are consciously aware that the information that they retrieved was from the study episode. In the other state, participants involuntarily retrieve the information through automatic processes and they have no conscious awareness that the information they retrieved was from the study episode. This procedure fails to distinguish a further state of phenomenological awareness that can be present during the solution of an incidental test. Participants may automatically produce studied information and then be aware that the retrieved information was from the study episode (Richardson-Klavehn & Gardiner, 1996; Richardson-Klavehn, Gardiner and Java, 1994, and 1996). In incidental tests, participants often report some awareness of a relationship between the study phase and the test phase when this relationship is not explicitly pointed out to them. Nevertheless, this awareness does not prompt the use of a voluntary retrieval strategy (Richardson-Klavehn et al., 1994) which, in any case, would be more effortful.

The confusion between retrieval volition, which implies the mental intention of wilfully retrieve information from the past episode, and state of awareness, the phenomenological state of being aware that information has been encountered in a previous episode, permeates most ways of thinking about memory and has led to a number of misconceptions (Richardson-Klavehn et al.,1996). The possibility that, during an exclusion task, some items may be retrieved involuntarily but then they become conscious, leads to a substantial underestimate of retrieval magnitude based on an involuntary strategy and to an overestimate of the contamination of incidental retrieval tests. This procedure is excellent at isolating involuntary unconscious memory but ignores the conscious correlates of involuntary memory.

In this thesis the framework developed by Richardson-Klavehn et al. (1996) in relation to retrieval volition and consciousness is adopted. In this framework, as in the PDP approach, a first distinction is made between *retrieval strategies* which can be either *voluntary* or *involuntary* and retrieval tests, termed *intentional* and *incidental*, to allow for the lack of a one to one mapping between the two constructs. In fact, tests may not be process pure: Intentional tests may be resolved with involuntary retrieval strategies and incidental test can be contaminated by voluntary retrieval strategies. (An involuntary strategy may look like a contradiction in terms, but what is meant is that the strategy is involuntary "with respect to memory for the events whose impact is under study" (Richardson-Klavehn, et al., 1996, p.89)). A second important distinction in this framework is made between *retrieval strategies* (voluntary vs. involuntary) and memorial *states of awareness*, which can be either conscious or unconscious. This distinction allows for both conscious and unconscious expressions of involuntary memory (priming).

A logical consequence of this approach is also both a conscious and unconscious expression of voluntary memory. Richardson-Klavehn et al. (1996) propose that a *voluntary unconscious* form of memory could possibly be linked to a state when voluntary retrieval strategies recover information about items encountered in the absence of any form of remembrance of the study episode. Instead, within the *voluntary conscious* expression of memory, two further phenomenological states of awareness may be identified that are of relevance to this thesis, "remembering" and "knowing" (Tulving, 1985). "Remembering" is a state of awareness in recognition tests whereby a voluntary retrieval strategy leads to the recovery of information about the study episode experienced as a re—livingof the study episode. "Knowing" is a state of awareness in recognition tests experienced as familiarity when participants engage in voluntary retrieval during recognition tasks. This state of awareness is experienced when items feel familiar, as if they had been encountered at an earlier stage but no conscious recollection of the earlier encounter is experienced.

1.3 Theoretical Approaches to the Study of Dissociations between Performances in Intentional and Conceptual Incidental Tests

Theories that attempt to account for the differences between incidental and intentional task performances are numerous, but they may be classified into two broad approaches. One approach posits the existence of multiple different systems that mediate the realisation of the two tasks. The second approach emphasises the role of separate *processes* in explaining dissociations between the two retrieval tests and tends to conceptualise memory in a more unitary way in terms of representations. The two approaches propose conflicting distinctions as the crucial ones that characterise and explain mnemonic function. The emphasis in the multiple systems approach is on the existence of separate neural systems mediating involuntary and voluntary memory. Advocates of the processing approach instead champion the distinction between perceptual and conceptual processing requirements of the task as the crucial distinction.

In the subsequent sections, the main theories put forward within the system and processing approaches are briefly reviewed. Recently though most theorists from the processing perspective (e.g., Roediger, Buckner, & McDermott, 1999; McDonald, Ergis, & Winocur, 1999) have embraced a components-of-processing theory as the best account of the available evidence. The main tenets of this theory are here described.

Activation theories of involuntary memory are also reviewed. In this section particular attention is given to two more recent theories, that of Bower (1996) in particular and that of Nelson, McKinney, Gee, and Janczura (1998) to a certain extent. These theories have maintained an activation view of priming but they also focus on the nature of the representation elicited by intentional and incidental tests. By doing so, Bower's (1996) approach in particular, has been found to propose the best explanation of the results obtained in the series of studies reported in this thesis.

1.3.1 Multiple Memory Systems Theory

According to this approach, functional and neuropsychological dissociations are explained by positing the existence of different memory systems that mediate performance on the different tasks. Theorists identify, at both a functional and a neurological level, a collection of systems that are differentially engaged according to the requirements of different tests of memory.

At first, only two memory systems were postulated: one engaged by intentional tests and one engaged by incidental tests. The organisation and characteristics of the systems varied from theory to theory (e.g., episodic vs. semantic, Schacter & Tulving, 1982; declarative vs.

procedural, Squire & Cohen, 1984). As more was learned about incidental and intentional retrieval, proponents of the memory systems approach began to fractionate the system that was hypothesised to support involuntary memory into further subsystems.

A more current version of the multiple system theory identifies, at both the functional and neurological level, a collection of subsystems that mediate performance on perceptual incidental tests of memory. Tulving and Schacter (1990) proposed a distinction between an episodic memory system that is responsible for the voluntary conscious retrieval of past events and a *perceptual representation system* (PRS) underlying priming (Schacter, 1990, 1992; Tulving & Schacter, 1990). The episodic system is favoured by elaborative processing of the material to be retained and its functioning is found to be impaired in amnesic patients. The PRS, which is intact in amnesic patients, mediates the involuntary access to pre-semantic and perceptual information that is expressed as priming.

Schacter (1992) proposed a further fractionation of the PRS into domain-specific subsystems dedicated to process a specific type of perceptual information such as visual or auditory information. These domain-specific subsystems operate at a pre-semantic level where the meaning of the word is not available. Perceptual repetition priming is a function of the reactivation of stored, domain-specific, representations. Because the representations involved are perceptual in nature, this approach explains why performance in such tasks is affected by perceptual variables such as study-test modality shifts. Instead, the lack of conceptual elaboration effects is explained by the operation of the domain specific subsystems at the pre-semantic level. One important feature of PRS subsystems is that they are characterised by the non-conscious expression of memory. The output from these subsystems can activate non-conscious procedural systems that mediate behaviour without awareness. Alternatively, the output is available to a Conscious Awareness System, which is associated with the phenomenological awareness of previously perceived material (Schacter, 1989). When a stored representation in the PRS is reactivated, it produces an output that, if it is available to the conscious awareness system, is consciously experienced as a percept.

Performance on intentional tests is conceived as mediated by a system that processes both semantic, multimodal and contextual information. The anatomical structure hypothesised to mediate performance in intentional tests has been identified with the hippocampus and related structures in the medial temporal lobe and the diencephalon (Squire, 1992). The hippocampal component is seen as an episodic memory module that processes information accompanied by conscious awareness. For conscious awareness to be experienced, information has to be processed by the hippocampal component. The component binds into the memory representation the neural elements that mediate conscious experience. In this way, consciousness becomes an intrinsic property of the memory trace.

Other systems theorists, like Tulving (1985), maintain that different kinds of consciousness are inherent properties of specific memory systems. Autonoetic consciousness is associated with episodic memory and it produces the phenomenal experience of remembering personally experienced past events. This phenomenal experience of remembering is different from other kinds of phenomenal awareness such as those involved in thinking and perceiving for example. According to Tulving's (1985) earlier formulation, the system that mediates performance on perceptual incidental tests is associated with anoetic consciousness.

In order to accommodate the further distinction between perceptual and conceptual priming within a systemic account, system theories had to be further refined. One suggestion, which has not been fully developed into a theory of conceptual priming, is that performance on conceptual incidental tests is mediated by yet other systems. In an earlier formulation Schacter (1990) argued for the possible reliance of conceptual priming on processes that occur outside the PRS. Later on, Schacter (1994) makes a more specific proposal that the priming of new associations and conceptual priming is mediated by a common semantic memory system. The acquisition of new semantic knowledge probably requires the hyppocampal component to come into operation. What is crucial in the characterisation of conceptual priming in Schacter's (1994) formulation is that this type of memory shares with perceptual priming the association with the non-conscious, or better, involuntary character of information retrieval. However, conceptual priming differs from perceptual priming as the former relies on the conceptual elaboration of the information to be acquired and is not modality specific.

1.3.2 Transfer-Appropriate Processing

An interpretation of dissociations that is alternative to the multiple memory system theory is the *transfer appropriate processing* (TAP) account of memory. This approach stemmed from a different tradition in the study of memory that emphasised the role of mental processes to explain cognitive performance (e.g. Kolers, 1975; Kolers & Roediger, 1984). Cognitive performance in memory tasks was described as skilled performance that becomes skilled following the transfer of the same processes from one task to another. The concept of transfer appropriate processing was introduced by Bransford, Franks, Morris, and Stein (1979) who argued that the critical element of memory performance was the interaction of processes engaged during the encoding phase and the retrieval phase. According to the TAP account the dissociations found between intentional and incidental memory tests are a consequence of the type of processing that are called upon by different retrieval demands. Memory performance is dependent on the extent to which cognitive operations that were engaged during the initial encoding of material are engaged when the material is retrieved. Performance on memory tests is a function of the extent to which these cognitive operations recapitulate those involved at study.

Incidental memory tests demand different cognitive operations or different types of information than those demanded by intentional tests. Consequently, different tests benefit from different types of processing engaged at study. The incidental memory tests most commonly adopted demand primarily perceptually governed processes; they are data-driven. Most typical intentional tests, such as recall and recognition, instead largely rely on conceptual operations; they are conceptually driven. The degree of perceptual processing at encoding therefore has an effect on incidental perceptual tests, while the degree of conceptual elaboration at encoding has an effect on intentional conceptual tests.

This line of reasoning would explain why depth-of-processing effects are not found in incidental memory tests that are mainly data-driven. It is their data-driven quality that is responsible for dissociations from intentional tests which are typically conceptually driven. It is not the involuntary nature of the retrieval strategy that determines the dissociations from intentional tests.

The TAP principle undermines the value of the voluntary/involuntary distinction as being an important explanatory variable that accounts for dissociations in memory. Intentional tests tend to involve conceptual processes in retrieving material, they are conceptually driven as they rely on elaborative processes, and incidental tests tend to rely on perceptual processes, they are data-driven. According to the TAP principle, intentional tests benefit from conceptual processing employed at study, instead perceptual test are dependent upon perceptual processes employed at study. An important conjecture based on the TAP principles was tested by Blaxton (1989). Blaxton (1989) reasoned that depth-of-processing effects should not occur when data-driven tests are made intentional, like for example a phonemic cued-recall task (where participants are asked to retrieve earlier studied words which rhyme with the cue word). More importantly, when an incidental test is made to rely on conceptual processes, as in conceptual incidental tests, depth-of-processing effects should occur. Experiments that support this view (Blaxton, 1989) show that by constructing an intentional test that relies on perceptual features and an incidental test that relies on conceptual features (e.g., a general knowledge test or a category-exemplar generation test), functional dissociations are obtained that do not respect the classical distinction between intentional and incidental tests.

According to the processing framework, the pattern of preserved and impaired performance of amnesic patients cannot be explained by the postulates of the systems approach. Instead, process theorists argue, that amnesics have intact data-driven or automatic processing, but impaired conceptually driven or controlled processing irrespective of the proposed memory system being tapped. Evidence for this view (e.g., Cermak, Verfaellie, & Chase, 1995) is explored in the later sections on amnesia.

1.3.3 Components-of-Processing Theory

The more recent theories championed within the systems approach propose many more subsystems than previously hypothesised. In many ways, these theories begin to resemble the components-of-processing theory developed by Moscovitch and Umilta (Moscovitch, 1989, 1992, 1994; Moscovitch & Umilta 1990, 1991; Witherspoon & Moscovitch, 1989). However, there are important differences between the systems account and the components-of-processing account. According to components-of-processing approach, unlike the processing approach, memory is not unitary and is instead mediated by independent components that can interact with one another. A combination of components is used for the solution of a given task. The dissociations in performance between different tests of memory are explained by the recruitment of different components, but other less crucial components could still be shared. Task performance is governed not only by one component's internal operation but also by a network of connections to other components which together form a functional unit or system. A single component can belong to a number of different systems.

Moscovitch and Umilta (1990, 1991) model the characteristics of the components on Fodorian modules (Fodor, 1983). Components are computational devices that have propositional content. They are domain specific in the sense that the components process only a specific type of information. They satisfy the criteria of "informational encapsulation" (Fodor, 1983) in the sense that they are not affected by higher order knowledge. Modules are cognitively impenetrable and only their output is available for conscious access. Thus, a module delivers its output to central systems where it is interpreted. Meanings are constructed in these more central systems. Central systems mediate the construction of strategies and plans that guide thought and action. The output of central systems is meaningful and available to consciousness.

Performance on incidental tests is mediated by the components involved in perceiving and interpreting incoming stimulus information: the perceptual input module and the semantic central system. The perceptual input module encodes events into structural pre-semantic representations. This modular component is domain specific and operates mandatorily and automatically at encoding and retrieval. This module requires medial temporal lobe/hippocampal and diencephalic structures to form the pre-semantic representation. The information that this modular component receives and delivers is controlled by a central component that can interpret its output semantically. The central component is a strategic component under voluntary control and requires prefrontal cortex structures for its operation.

The representation in the perceptual modular component and in the central component enables subsequent related events to be processed more quickly. The reactivation of perceptual modules predominately mediates the perceptual priming phenomenon and the reactivation of semantic representations predominately mediates conceptual priming.

Perceptual input modules are similar to the PRS subsystems described by systems theorists. The components and systems are both domain specific and encode pre-semantic, structural information. In this way, they explain modality effects on perceptual incidental tests. The reactivation of a perceptual record must be guided by its structural description; only new stimuli with similar structural representation as previously encoded stimuli will enable the reactivation of the established perceptual representation. Hence, priming is enhanced when the structural character of the test stimulus is similar to the earlier encoded stimulus. Conceptual elaboration at test instead has little influence on perceptual priming since the perceptual record is not semantic.

In relation to performance in intentional tests, according to the components-of-processing theory, only those memory representations that have consciousness bound to them can support voluntary remembering. Central system structures that retain semantic records may or may not have consciousness bound to them. Consequently, reactivating these semantic records does not imply that the reactivation would necessarily lead to conscious recollection. In this manner, the components-of-processing approach can allow space for conceptual priming. Performance on conceptual incidental tests is seen (Moscovitch, 1992;

Tulving & Schacter, 1990) to be mediated by the central system semantic structures that receive the output of perceptual modules and create a semantic representation.

1.3.4 Activation Theories

When priming effects were first reported, the priming phenomena were attributed to the temporary activation of pre-existing representations in memory (Graf & Mandler 1984; Mandler, 1980; Morton, 1969). This theory was no longer favoured in the light of new empirical findings. However newer versions of this theory have now been put forward (e.g., Bower, 1996). The presentation of a word in a study list activates its memory representation so that this word is more likely to be produced relative to other, inactivated words. Activation would be expressed behaviourally as a facilitation in accessing target words. Instead, activation alone is not sufficient to enable performance in intentional memory tests which is dependent on the relationships between the event and the characteristics of the *context* in which this event occurred. Performance on intentional tests is related to the formation, retention, and retrieval of longer-term memories that are dependent on the meaningful processing of the stimulus information. Elaborative processing implied forming associations to the stimulus event or generating images of the stimulus event and so on. Activation of pre-existing representations was taken to be relatively automatic, whilst elaboration processes were taken to be more attention demanding (Graf & Mandler, 1984).

In later versions of the theories, modality effects in priming were explained by the activation of modality specific representations. However, when it was found that priming persists over very long retention intervals (Jacoby & Dallas, 1981; Schacter, 1989; Tulving, 1983), the simple idea of a temporary activation had to be discarded. It seemed that longer lasting memory representations were responsible for priming. Furthermore, when it was found that priming could be obtained for new material and new associations this created a further difficulty for the theory that the activation of pre-existing representations was responsible for priming.

However, a number of recent theories (e.g., Bower, 1996; Dorfman, 1994, 1998) have retained some of the ideas proposed within the activation/elaboration approach by proposing important modifications which deal with the issue of slow decay of priming and the priming of novel material.

Bower (1996) describes an extension of a traditional memory theory that, by focusing on the nature of representations, explains a variety of voluntary and involuntary memory phenomena without referring to memory systems. Earlier distinctions between different classes of memory units, such as sensory features, logogens, imagens, concepts and context tags, are re-proposed as a way of interpreting priming phenomena. The presentation of a stimulus has the effect of strengthening the associations between specific sensory features and logogens. Perceptual priming occurs when the new stimulus reactivates some of the same sensory features of an earlier presented item which then results in the activation of the logogens. Conceptual priming is instead the result of the strengthening at study of associations among concepts, usually enabled by elaborative processing. When some aspects of these concepts are presented at retrieval, the conceptual associations are reactivated and conceptual priming occurs. Associations between concepts and logogens also play a part in associative priming when these associations are reactivated.

To explain intentional memory performance, Bower (1996) proposes that when a stimulus event is presented at study, a new association is established between the stimulus and the personal context of the presentation, thus establishing an episodic memory. These associations between the item's sensory features, logogens, and its contextual tag are responsible for performance in memory retrieval tests where awareness of the context is a requirement.

An important premise of the theory is that presentation of a stimulus strengthens its sensory and contextual associations independently. Because of this independence, the dissociations found between performance in incidental and intentional tests can be explained. The theory postulates that neurologically impaired patients, that have difficult with intentional memory tests, have particular problems in establishing associations between events and the personal context, but have no difficulty in just establishing associations between sensory features and logogens.

The theory deals with the problem of priming following long retention intervals by postulating that the activation has the function of strengthening associations between concepts or the associations from the sensory features to the logogen. It is this *strength* that is expressed as priming, not the transient activation.

Priming for novel information can also be integrated within this theory by adopting a sub-lexical view of item representation (Dorfman, 1994, 1998). A lexical assumption would imply that the representations responsible for priming are single word-level units. A sub-lexical view instead advocates the importance of lower level units in priming where item are represented by a combination of connections between lower level units. Lower level units are common to novel and established information. The activation of lower level units in the case of novel information is responsible for priming with this material.

Bower's (1996) activation theory can explain priming phenomena and dissociations without appealing to systems explanations or process explanations. It is different from the systems approach as it does not demand multiple representations. It differs from the process approach as the conceptual/perceptual distinction has a different role. However, this theory has not yet gained wider acceptance and tests of the theory have not been implemented. Reference to this theory will be made in the final chapter (Chapter 7) as being the most comprehensive explanation of the results obtained in the experiments reported in this thesis.

Another theory that can be also be considered an activation theory, is Nelson et al. (1998) account which emphasises the role of the activation of a specific type of representation during the incidental test. Nelson et al. (1998) argue that different retrieval instructions engage two different types of representation formed during the study phase. Priming engages an *implicit representation* which is a consequence of automatic activation. The *implicit representation* is recovered when the presentation of a word activates its lexical representation. This activation directly activates meaningfully related associates. Nelson et al. (1998) describe this activation as representing some form of automatic/unconscious memory retrieval and produces an implicit representation of the word and its associates.

Instead, voluntary retrieval engages an *explicit representation* created as a consequence of conscious processing. The *explicit representation* "is created as a result of processing operations consciously deployed by the participant to meet task demands" (Nelson et al., 1998, p. 302). The obtained representation includes contextual information and connections to other words in the list. The strength of the *explicit representation* is modulated by the type of processing at study. The two representations are independent and retrieval instruction can bias the recovery of the particular representation.

The proposed distinction between representation types is also found useful as an account of some of the results obtained in the empirical studies reported in this thesis.

1.3.5 The Way Forward

In light of recent evidence, some researchers (see Foster & Jelicic, 1999) are embracing the idea that there is not a strong conflict between processes and systems in accounting for memory phenomena. Tulving (1999) argues that the debate is between believers in a unitary memory system with *single* representations that mediate *all* memory phenomena and believers in multiple memory systems with *multiple* distributed representations that are independently summoned by task demands. Mayes (1999) instead argues that the debate is between which kinds of systems is the one with higher explanatory power, the systems described by the voluntary/involuntary dichotomy, or the ones described by the perceptual/conceptual dichotomy. Other authors (e.g., Baddeley, 1997) see the processes vs. systems dichotomy as a false one: *Processes* are carried out by *systems,* and a comprehensive theory should account for the operation of the processes within the structural organisation of various systems.

Some theorists who have championed the processing theory now embrace the components-of-processing theory proposed by Moscovitch and his colleagues (Moscovitch, 1989, 1992, 1994; Moscovitch & Umilta 1990, 1991; Witherspoon & Moscovitch, 1989). Roediger, Buckner, and McDermott (1999) argue for a conceptualisation of memory as proposed within this theory whereby the emphasis is placed on the sharing of components during an information processing task. They conceptualise memory as the sharing of processes when different tasks make different processing requirements. In this way, the processing distinctions are emphasised but the operation of interacting subsystems to explain dissociations is also retained. McDonald, Ergis, and Winocur (1999) also embrace a components-of-processing view and emphasise the dissociations that are obtained between components rather than the sharing of several components in one task. Instead Blaxton (1999) makes the case for a conceptual and a perceptual brain system and argues that both the conceptual/perceptual distinction made by process theorists and the incidental/intentional distinction made by systems theorists are valid and necessary to explain the totality of memory phenomena. Blaxton (1999) argues that it is profitable to take into account both these insights to further knowledge of memory.

The processing view can be seen as constraining the systems view by emphasising the connections between systems and suggesting alternative processing distinctions. The most profitable way for retaining a system idea is to investigate the specific processing contribution of the various brain areas without making assumptions about the location of representations and the isolated recruitment of the processing in such locations by only one mental operation. The way to address the problem is to gain a detailed understanding of the specific processes that underlie memory for different kinds of information.

The systems and processing position may not be at opposing poles. Recently, theories from both camps have changed to account for the available evidence. Opposing predictions are sometimes difficult to generate and hence the two types of theories are not easily distinguishable.

However, it can still be said that the different theories place very different emphases on the crucial features that better capture and characterise the nature of memory. Systems theorists still emphasise the incidental and intentional distinction, and thus the importance and the role of consciousness in memory. They try to understand this very important memory correlate and its role in memory function. Both the components-of-processing theory and the recent activation theories make an attempt to account for the role of conscious correlates in memory function. Processing positions are still quite mute in this respect; the emphasis is placed on the type of processes. Although the conceptual/perceptual distinction is very valuable in accounting for some of the recent findings (e.g., Blaxton, 1989), some other important and insightful distinctions may be under-emphasised within this framework.

The different theoretical accounts emphasise different study approaches and different explanatory aims to the subject matter of memory. The systems theory attempts to explain memory function in neurologically impaired populations and then generalises to the normal population. Process theorists instead attempt to explain experimental dissociations.

In this thesis the relative importance of the two proposed distinctions are considered further particularly in relation to the type of representations involved in memory tasks. By focusing on the type of representations involved in conceptual tasks it is possible to elucidate some conflicting results reported in the literature that have contributed to the debate between process and systems theorists.

We now turn to a review of most of the empirical findings relating to conceptual priming and of how these findings relate to the above theoretical accounts.

1.4 Memory Dissociations as a Function of Participant Variables

The review first examines how participant variables modulate conceptual priming. Studies of conceptual priming have been carried out mainly with amnesic, but also with Alzheimer's disease and schizophrenia patients. The performance of older adults and of children in conceptual incidental tests has also been observed in a few studies. Each of these populations is reviewed in turn.

1.4.1 Amnesia

Recent studies of conceptual priming in amnesia have attempted to investigate the critical distinction between aspects of memory that better characterises amnesic impairment. Supporters of the TAP framework argue that amnesic patients have impaired conceptually driven processes but have intact data-driven processes and the voluntary/involuntary memory distinction is not critical in explaining deficits. The theory predicts that amnesics are impaired in all tests requiring conceptual processing and not in perceptual tests, whether these tests are intentional or incidental in nature. According to the systems approach, the critical dissociation that explains amnesic impairment and better characterises mnemonic structures is instead between normal involuntary and deficient voluntary retrieval of encoded information. The theory predicts poor performance of amnesic patients in intentional memory tasks but normal repetition priming regardless of the perceptual or conceptual nature of the test.

Performance on conceptual incidental retrieval in amnesics constitutes crucial evidence in assessing the merits of the systems and processing accounts. Evidence in the literature of conceptual priming in amnesia is often conflicting. However, overall the experimental evidence suggesting a normality of conceptual priming seems to be predominant. In a review of conceptual and perceptual priming in amnesia, Vaidya, Gabrieli, Keane, Monti, Gutierrez-Rivas, & Vanderlinden (1992) reports that there are now many studies which have demonstrated that even severely amnesic patients may show preserved perceptual and conceptual priming for previously familiar information and for novel information.

Cermak, Verfaellie, and Chase (1995) directly tested the hypothesis of the processing approach that conceptual priming is impaired in amnesia in the same way that intentional retrieval is. They compare performance on four tasks. Two tasks were an intentional and incidental version of a data-driven test. Words that looked similar to target words were used as cues for producing the first graphemically similar word that came to mind in the incidental test or as cues for recalling graphemically similar studied words in the intentional test. The other two tasks were an intentional and incidental version of a conceptually driven test. Words semantically associated to the target words were used as cues in an incidental free association task and in the intentional word associate cued-recall task. The authors found that the nature of the test instructions consistently determined the pattern of impaired and normal performance in amnesics regardless of the processing demands of the tasks. The voluntary/involuntary distinction seemed to capture the nature of the impairment of amnesics better than did the distinction between data-driven and conceptually driven processes.

In a recent study by Keane, Gabrieli, Monti, Fleischman, Cantor, and Noland (1997) further evidence is provided for non-impaired performance in amnesics in the conceptual incidental task of category-exemplar generation. In this study, patients showed a normal depth-of-processing effect in conceptual priming prompting the authors to suggest that conceptually based processes at study are operating normally and the impairment is more related to retrieval processes.

A similar finding was obtained in amnesic patients with the free association task. Vaidya et al. (1995) reported that 56 amnesic patients showed impaired performance on the intentional test of word associate cued-recall in comparison to intact performance on the incidental test of free association. Carlesimo (1994) also studied performance in amnesics on the word association task where he used strongly related words. He found that amnesic patients displayed normal conceptual priming. In this study, as in the Keane et al (1997) study on category-exemplar generation, the magnitude of priming in the free association task (but not in the word identification task) was enhanced by conceptual elaboration at study. Furthermore, conceptual priming did not show a modality effect.

Shimamura and Squire (1984) and Graf, Shimamura, and Squire (1985) reported normal priming in amnesic patients in both the free association and category-exemplar generation task. In these studies, the test of amnesics' conceptual processing was even more controlled as the retrieval cues presented at test had not been presented with the target during the study phase. This total lack of perceptual overlap between the studied word and the retrieval cue prevented participants from making use of any perceptual process to facilitate priming.

The findings reported thus far point to an inconsistency with the characterisation of the memory deficit in amnesia as being one of conceptual processing per se. However, there is some experimental data supporting impairments of conceptual priming in amnesics. This data derives primarily from studies involving stem completion for new associations (e.g., Cermak, Bleich, & Blackford, 1988; Graf & Schacter, 1985; Shimamura & Squire, 1989). In this experimental paradigm introduced by Graf and Schacter (1985, 1987; Schacter & Graf, 1986, 1989), participants study unrelated word-pairs (e.g., *window-reason*). In the test phase, participants carry out a stem completion test in which the word stem is presented together with, either the paired word from the study phase or with some other unrelated word. When more target stem-completions are made when the same studied pair is reproposed at test (*e.g., window-rea?*), than when a new pairing is presented (e.g., *table-rea?*), the priming of the studied association is inferred. Graf and Schacter (1985) found that a new association is primed only following elaborative study processing. Poor priming of new associations in this task by amnesic patients has been reported despite the test engaging involuntary retrieval. This deficit obtained in this incidental test can be seen to parallel amnesics' deficit in voluntary retrieval. This parallel result in the two tests suggests that it is not voluntary retrieval per se that is impaired in amnesics but it is amnesics' conceptual processes that are impaired. This impairment of conceptual processes would explain deficits in both the voluntary and involuntary retrieval of new associations in amnesics.

It is worth noting that the tasks adopted in these studies involve the priming of *new* associations. These tasks differ from other conceptual priming tasks in that they require the learning of new associations between unrelated words. This point will be elaborated upon during the course of the thesis.

There is though some other type of evidence that, instead, emphasises the role of the conceptual/perceptual distinction in explaining amnesics' deficit. For example, Brunfaut and Dydewalle (1996) looked at the performance of Korsakoff amnesic and alcoholic patients in three incidental memory tasks. These included two perceptual tasks and a free association task. Retrieval in the incidental tests was compared with retrieval in the intentional test of stem cued-recall. Korsakoff patients did not show a benefit from elaborative processing in free association and cued-recall tasks, but had normal perceptual priming performance. On the basis of these results the authors suggested that Korsakoff patients have specific deficits with conceptually driven processing rather than intentional retrieval: The authors argued that the incidental or intentional nature of the memory task was not critical.

Blaxton (1992), in a study involving left temporal lobe epileptic patients, also provided some evidence supporting deficient conceptual processes in amnesia. Blaxton (1992) reports that these patients performed normally on data-driven tasks but below normal levels on conceptually driven tasks regardless of whether they were associated with voluntary or involuntary retrieval instructions. These findings are also supported by a PET study by Blaxton, Bookheimer, Zeffiro, Figlozzi, Gaillard, and Theodore (1996), in which regional cerebral blood flow was measured during performance of data-driven and conceptually driven retrieval tasks. This preliminary set of PET results, comparing activation in the two types of tasks, showed several areas of activation that were specific to either perceptual or conceptual processing. Conceptual retrieval tasks activated mid and left hemisphere frontal and temporal regions and the lateral aspect of bilateral inferior parietal lobule. Data-driven tasks activated right frontal and temporal regions and bilateral activation of more posterior regions was also observed. Instead when the incidental and intentional versions of the conceptually driven test of word-association was compared, the authors argued that that the similarities in the regions of activation were rather striking. However, some differences in activation between voluntary and involuntary retrieval were reported.

1.4.2 Alzheimer's Disease

Temporal lobe amnesics and patients with Alzheimer's disease have similar intentional memory impairments, but their performance on incidental memory tests differs in systematic ways. From the pathology of Alzheimer's disease, Gabrieli (1996) proposed that Alzheimer's disease patients should exhibit preserved performance on perceptual incidental tasks and reduced performance on conceptual tasks. Occipital memory structures mediating performance in perceptual incidental tests appear to be unaffected by Alzheimer's disease (or ageing). Instead, structures in the frontal lobe, are affected by the disease (but not by normal ageing), and it is these structures that are hypothesised to mediate involuntary conceptual memory.

To test this hypothesis, Monti, Reminger, Gabrieli, Rinaldi, Wilson, and Fleischman (1996) examined the performance of Alzheimer's disease patients on a category cued-recall task and a category-exemplar generation task. They found that Alzheimer's patients had reduced performance for both intentional and incidental forms of the conceptually driven task. Maki (1995) also reports that, whereas amnesics show preserved incidental memory across a variety of tasks, individuals with probable Alzheimer's disease generally show preserved incidental perceptual priming, but impaired conceptual priming.

However, the results from a meta-analysis of studies on involuntary memory in Alzheimer's disease (Meiran & Jelicic, 1995) do not grant the conclusion that Alzheimer's disease impairs only conceptual priming leaving intact perceptual priming. Meiran and Jelicic (1995) in fact found that, overall, these patients were significantly impaired in both conceptual and perceptual incidental tests (in particular if they were younger than 75 years of age). To stress this point further, there are also some reports of preserved conceptual priming in Alzheimer patients. Maki and Knopman (1996) report that conceptual priming performance can reach normal levels in Alzheimer's disease patients when the words to be recalled incidentally at test were generated at study rather than simply repeated. And, contrary to Monti et al (1996), Jelicic (1996) found normal level of conceptual priming in the category-exemplar generation task.

1.4.3 Schizophrenia

Only one study to date was found in the literature on conceptual priming in schizophrenic patients. In Schwarz, Rosse and Deutsche's (1993) study, schizophrenic patients were found to be impaired in intentional tests, but to show normal performance in incidental tests regardless of the type of processing (conceptual/ perceptual) required by the task's demands. In the incidental conceptual test of category-exemplar generation and in the incidental perceptual test of word identification, schizophrenic patients exhibited normal performance. In the corresponding intentional tests of category cued-recall (conceptual driven) and graphemic cued-recall (data-driven), schizophrenic patients were found to be impaired. These results show a dissociation between intentional and incidental test performance under conditions in which the two tests involve the same types of processes, either perceptual or conceptual. This result in schizophrenic patients strongly supports the emphasis placed on the voluntary/involuntary dichotomy as the distinction with higher explanatory power of memory phenomena than the perceptual/conceptual dichotomy.

1.4.4 Ageing

In a study of conceptual priming in older adults, Jelicic, Craik, and Moscovitch (1996) suggested that the dissociation between perceptual and conceptual priming might be more crucial in understanding memory performance reduction in older adults than in amnesic patients. Jelicic et al. (1996) demonstrated large age-related decrements on perceptual and conceptual intentional memory tasks, regardless of the perceptual/conceptual processing involved in the intentional retrieval tests. The effect of ageing was found to be much smaller in the incidental tests: No differences were found on the perceptual incidental task of word-fragment completion, but older participants showed less priming on the conceptual test of category-exemplar generation.

Grober, Gitling, Bang, and Buschke (1992) also report findings of reduced conceptual priming in older adults in the incidental test of category-exemplar generation. And, in a review of the literature on ageing and involuntary memory, Rybash (1996) also concludes that normal ageing is likely to diminish performance on conceptual incidental tests, but does not have a negative effect on incidental perceptual tests.

Contrary to findings of impaired conceptual priming in older adults, Light and Albertson (1989), Isingrini, Vazou, and Leroy (1995), and Monti et al. (1996) found comparable priming effects for young and older adults in the category-exemplar generation test in conjunction with reduced intentional retrieval. In the word association test, there is also evidence of preserved conceptual priming in older adults (Java,1996).

A set of experiments by Howard, Fry, and Brune (1991) looked at priming for newly acquired associations using the experimental paradigm developed by Graf and Schacter (1985, 1987; Schacter & Graf, 1986, 1989). Age differences were found in involuntary memory for new associations following shallow encoding. However, age differences were not reported in the incidental test when older adults encoded the pairs of words by creating their own sentences at their own pace. The effect of age was reported in all intentional tasks regardless of whether conceptual elaboration occurred or not at study. However, a study by Ergis, Van-der-Linden, and Deweer (1998) also using the same experimental paradigm found that older adults did not demonstrate any priming for new associations, whereas young participants did.

1.4.5 Children

Studies of perceptual involuntary memory in children tend to show normal priming but less efficient voluntary retrieval compared to adults. These findings led researchers to hypothesise that involuntary memory emerges earlier and is more stable from childhood to adulthood than memory tapped by intentional tests.

Mecklenbrauker and Wippich (1995) attempted to test the generalisation of this finding to conceptual priming. In two experiments six-year-olds and school-aged older children were compared on incidental and intentional versions of the conceptual tests of category exemplar generation. Mecklenbrauker and Wippich (1995) found that older children outperformed younger children in the category cued-recall task, but conceptual priming did not vary with age.

This study supports the usefulness of the involuntary/voluntary dichotomy in describing memory phenomena. Involuntary memory, rather than data-driven processes, seems to be developed earlier in life and this is expressed with similar perceptual and conceptual priming in younger and older children. Instead, voluntary memory, rather than conceptual processes, seems to develop later as older children outperformed younger children in the intentional test.

However, Perez, Peynircioglu, and Blaxton (1998) also compared performance of three age groups (pre-school, elementary school and college students) on incidental and intentional versions of a conceptual task. They also compared performance on incidental and intentional versions of a perceptual task. At encoding, items were studied with either a perceptual or a conceptual orienting task. Performance in the conceptual intentional test showed an effect of age with performance improving across age groups. Instead, performance on both perceptual and conceptual incidental memory tests, as well as on the perceptual intentional tests, showed no effect of age. In this case, support for the voluntary/involuntary dichotomy is less strong as the perceptual intentional test was also not affected by age. Nevertheless, the hypothesis of a deficit of conceptual processes in children is also not fully supported by the results as an effect of age should have been reported in the conceptual incidental test. Furthermore, conceptual elaboration at study favoured memory performance in the conceptual intentional test but, more importantly in this thesis, it had no effect on performance in the conceptual incidental test.

1.5 Experimental Dissociations

This section presents a review of all the experimental manipulations applied to conceptual incidental tasks found in the literature. All the studies that have looked at the effects of experimental manipulations on conceptual priming in the literature have a common underlying rationale. Variables that have a well-known effect on voluntary retrieval are tested with respect to their effects on involuntary conceptual retrieval. The presence of "associations" between the two forms of retrieval (i.e. both forms of retrieval are affected by the experimental variables to similar degrees), has been interpreted in favour of a processing approach as evidence of the demand of a common set of processes to resolve the retrieval task. Instead, the presence of "dissociations" between the two forms of retrieval has been interpreted as supporting the voluntary/involuntary construct in explaining memory phenomena. Each variable is reviewed in turn.

1.5.1 Generate/Read

Blaxton (1989), Roediger and Blaxton (1987), and Roediger, Weldon, and Challis (1989) suggested that the generate/read manipulation could be used to define operationally perceptual and conceptual incidental tests. In reading a word, the spoken response is driven by "bottom up" processes, where from the perceptual stimulus of the letters reading is driven up through the perceptual system. Generating is instead a "top down" conceptual process because a participant has to generate a word without any help from a perceptual stimulus. There is no perceptual resemblance between the cue and the word produced. Because generating from a definition (or a picture or an associative cue) is a conceptual operation, a test showing an advantage of prior generating over just reading in the study phase should be considered a conceptual test. Instead, reading a word out of context must be carried off by driving the information bottom up through the perceptual system; prior reading of words should then transfer better to incidental tests that involve trying to name words from word cues which are data limited.

Blaxton (1989) used the generate/read contrast to dissociate perceptual from conceptual tests. In the read condition participants read words aloud (e.g., *cold*), and in the generate condition participants produced a target from an opposite cue (*hot -c* ?). Prior generation of words led to better performance than reading words on both intentional (free-recall, cued-recall) and incidental (general knowledge questions) conceptual tests. By contrast, the reverse occurred for perceptual incidental and intentional tests, where reading, as opposed to generating words conferred an advantage at test.

Later studies showed a similar effect of generation at study on conceptual incidental tests. Roediger and Srinivas (1990) tried a generate/read manipulation on a category-exemplar generation task and showed that generating at study produced greater priming than reading in this task as well. Java (1996) also reported a generation effect in the incidental version of the word-association task in both older adults and young participants. Nyberg and Nilsson (1995) found that compared to reading, generation was found to improve performance in both free recall and category association tasks.

However, there have also been some demonstrations of the unreliability of the generation effect on conceptual incidental tests. Tajica and Newman (1992) partially replicated Blaxton's (1989) findings. In Tajica and Newman's (1992)first experiment performance in a recognition task was affected by the generate/read manipulation with generation conferring an advantage. But this generation effect was not so marked in the incidental conceptual test of general knowledge. As expected in the perceptual test of graphemic cued-recall (intentional) and of word-stem completion (incidental), a generation effect was not found. However, more importantly, in their second experiment they found that there was no generation effect in the conceptual incidental test of general knowledge despite its reliance on conceptual processes, and a generation effect was found in the intentional perceptual test of graphemic cued-recall. Thus the opposite pattern to Blaxton (1989) was obtained favouring a systems explanation. The difference between Experiments 1 and 2 in Tajica and Newman's (1992) study was simply in the incidental retrieval instructions. The difference between the results in the two experiments was attributed to participants failing to understand the incidental retrieval instructions in the first experiment which led them to purposely avoid those words that they realised were in the studied lists. In the second experiment participants were instructed to just produce the first word that came to mind regardless of whether it was studied or not. An appropriate understanding of the incidental retrieval instructions led to no generation effects in the conceptual incidental test of general knowledge and a generation effect on the perceptual incidental test of graphemic cued-recall.

1.5.2 Divided Attention

The role of attention during encoding is important to many current accounts of the involuntary/involuntary memory distinction. According to the systems' view, intentional tests demand attention when stimuli are encoded, whereas, incidental memory tests, whether perceptual or conceptual, reflect automatic (non-attention-demanding) encoding processes. According to the process approach conceptually driven retrieval test, whether demanding voluntary or involuntary retrieval, both require attention when stimuli are encoded. Tests of conceptual priming and their response to divided attention at study are in a unique position to test between the two alternative accounts.

Mulligan and Hartman (1996) investigated the effects of dividing attention during encoding on an incidental conceptual test of category-exemplar generation and on a perceptual incidental test of word-fragment completion. The effect of divided attention was compared with the intentional versions of the conceptual (category cued-recall) and perceptual tests (word-fragment cued-recall). Dividing attention during encoding decreased performance on both intentional memory tests. In the incidental versions of the tests, an effect of divided attention was found only for the conceptual test of category-exemplar generation but was absent in the perceptual test of word-fragment completion. The results support the processing approach and suggest that incidental conceptual tests, in the same way as intentional tests, are disrupted by divided attention at encoding and therefore they are not automatic, and possibly not involuntary.

Contrary to Mulligan and Hartman (1996), Isingrini, Vazou, and Leroy (1995) also investigated the effects of divided attention on the category-exemplar generation task and the category cued-recall task. and found that only performance on the intentional test was affected by the manipulation of attention. This kind of evidence instead supports the relevance of the voluntary/involuntary dichotomy for explaining memory phenomena.

In a more recent study, Mulligan (1997) tried to account for the discrepancy between the Mulligan and Hartman (1996) study and the Isingrini et al. (1995) study by adopting a finer grain manipulation of attention at encoding. Mulligan (1997) was able to manipulate levels of attention at encoding by varying short-term memory load. During encoding, participants were required to carry out a concurrent task in which an increasing number of attended digits had to be reported. Mulligan (1997) found that dividing attention decreased performance on the category-exemplar generation task and its intentional version of category cued-recall in different ways. Weak divisions of attention reduced performance in the intentional category cued-recall task, but not performance in the incidental task. Strong divisions of attention instead reduced performance on both tests and conceptual priming was eliminated entirely. Mulligan (1997) also noted that the results he obtained satisfied the retrieval intentionality criterion (Schacter et al., 1989) with weak division of attention disrupting the intentional but not the incidental test. This, Mulligan (1997) argues, would have been difficult to establish if attention had been manipulated as a binary variable comparing full attention with only strong divided attention conditions.

From these series of studies it can be concluded that conceptual priming is less demanding of attention than voluntary retrieval, but in some situations dividing attention at study will create some disruption of conceptual priming. On the basis of the results obtained in experiments in this thesis, the concluding chapter will attempt to explain why the full expression of conceptual priming demands attention at encoding in some circumstances but not in others.

1.5.3 Picture Superiority Effect

Pictures are usually remembered better than words in voluntary retrieval tasks. According to the processing framework, because pictures engage more conceptual processing than words, more priming should be obtained for pictures over words in incidental conceptual tests. Weldon and Coyote (1996) investigated this hypothesis and found no significant advantage in the priming of pictures over words in the incidental tasks of category-exemplar generation and word association. Instead, pictures were better recalled in the intentional versions of the tasks. McDermott and Roediger (1996) also obtained a picture superiority effect in free recall but not in the incidental task of category-exemplar generation. A similar study looked at the picture bizareness effect. Nicolas and Marchal (1998) found that in an intentional test, pictures are better recalled when they are studied in "bizarre" format, but a picture bizareness effect had no effect in the incidental conceptual test of word association. However, with a depth-of-processing manipulation at study, the picture superiority effect in priming becomes more complex. The findings of a dissociation between performance on conceptual incidental tests and performance on intentional tests is not predicted by the processing framework. The obtained difference between the tests suggests that visual distinctiveness is an important variable that modulates recall but not incidental conceptual retrieval.

1.5.4 Conceptual Repetition

McDermott and Roediger (1996) attempted to examine whether conceptual repetition effects, which are found in intentional tests, could also be found in a conceptual incidental test of category-exemplar generation. The processing account predicts that the intentional and incidental conceptual tests would show the same effects of conceptual repetition. Conceptual repetition at study was implemented by presenting a target word (e.g., *puzzle*) followed by an associate (e.g., *jigsaw*). This condition was compared to the simple presentation of the target word once. Conceptual repetition did not confer an advantage for priming in the category-exemplar-generation test over the simple presentation of the target. Conceptual repetition, though, had an effect on the intentional task of free recall.

This pattern of findings of a dissociation between conceptual intentional and incidental tests supports the value of the involuntary/voluntary dichotomy over that of the perceptual conceptual dichotomy. However, when conceptual repetition was implemented by following a picture with its corresponding word (or vice versa) there was an effect of conceptual repetition on intentional test of free recall but again no effect on the conceptual intentional test of category-exemplar generation or category cued-recall.

1.5.5 Enactment

Performance on intentional memory tests shows an effect of enactment during the encoding of simple imperatives whereby recall usually improves following enactment. Nyberg and Nilsson (1995) investigated the effect of this manipulation on a conceptual incidental test of category association and this was compared to free recall. They found that enactment affected free recall only and not conceptual priming. However, in another experiment in which participants were asked to imagine performing the tasks, they also found an effect of this manipulation in both the intentional and conceptual incidental test. Nyberg and Nilsson (1995) argue that their pattern of findings suggests that performance in intentional tests and incidental conceptual tests has a process in common that is sensitive to conceptual processing at study. Conceptual priming is enhanced by imagery but not by enactment. Instead, voluntary retrieval involves additional processes and is enhanced by elaborate encoding settings provided by enactment.

1.5.6 Serial Position

Brooks (1999) attempted to compare serial position effects obtained in voluntary retrieval with such possible effects in conceptual priming. In the association cued-recall task she found normal serial position effects for strongly related words: Enhanced recall was obtained for the earlier studied words and for the later studied words. Instead, in the conceptual incidental test of free association, primacy and recency effects were not observed for strongly related words. Weakly related words showed primacy and recency effects in both the intentional and incidental tests. This striking dissociation in the patterns of retrieval of items is important evidence of the usefulness of the voluntary/involuntary distinction.

1.6 Depth of processing

The previous section reviewed experimental variables in relation to conceptual priming, with the exception of depth of processing. This variable is here covered in two separate sections because it constitutes the main focus of this thesis.

When the distinction between intentional and incidental tests was first drawn, researchers had reported that a manipulation of depth of processing does not affect incidental memory tests in contrast to the robust depth-of-processing effect on typical intentional tests.

However, with the rise of conceptual incidental tests this tenet was no longer defensible. The categorisation of tests into perceptual and conceptual revealed a reasonably consistent pattern of effects. Earlier studies that investigated depth-of-processing effects consistently revealed an effect of depth of processing in conceptual incidental tests similar to effects reported in intentional tests. Hamann (1990), Mecklenbrauker, Wippich, and Mohrhusen (1996), Weldon and Coyote (1996), and Srinivas and Roediger (1990) demonstrated a depth-of-processing effect on the incidental conceptual test of category-exemplar generation. In amnesic patients, Keane, Gabrieli, Monti, Fleischman, Cantor, and Noland (1997) show a normal depth-of-processing effect in the incidental category-exemplar generation task. Hamann (1990), Challis and Sidhu (1993), Challis, Velichkovsky, and Craik (1996) and Thapar and Greene (1994) also found depth of processing effects in the conceptual incidental general knowledge test.

This kind of finding gave impetus to the TAP approach and undermined the role of the involuntary/voluntary memory distinction. In a typical study where the depth-of-processing manipulation is implemented, participants typically carry out two tasks: a deep/semantic task and a shallow/non-semantic task. In a semantic task, participants are forced to think about the meaning of the material to be retrieved in the subsequent test in order to successfully complete the task. In the non-semantic task participants have to think about the more superficial characteristics of the word (e.g., its syllables or its physical shape) to successfully complete the task. According to the TAP principle, those tests of memory that depend on conceptual information for their completion benefit more from semantic than non-semantic orientation tasks at study. Intentional retrieval and conceptual incidental retrieval are hence affected by depth-of-processing variations because participants benefit in both retrieval modes from the semantic processing of the words at study. Instead, depth of processing has no effect on perceptual tests because only perceptual processes are required when words are studied for the words to be fully expressed in involuntary perceptual retrieval.

Originally, a large number of investigations attempted to demonstrate that semantic processing does not produce a memorial advantage over non-semantic processing on incidental tests, as contrasted with the typical advantage in intentional tests. This was done though in particular for perceptual incidental tests which in general showed no depth-of-processing effect. Instead, in the few studies that employed conceptual incidental tests, in general, as reported above, depth-of-processing effects were reported. However, the picture on depth-of-processing effects in both perceptual and conceptual tests gradually began to be far less clear. In a review of 166 outcomes from 38 studies that have manipulated depth of processing of the material on incidental tests, Brown and Mitchell (1994) reported some important results. In 79% of the reviewed conditions, priming was greater following semantic than non-semantic processing, even if in the individual studies the difference was not significant. This difference was found in both perceptual and conceptual incidental memory tests, as well as for conditions employing either within or between participant designs.

Challis, Velichkovsky, and Craik (1996) carried out a detailed study of depth-of-processing effects on incidental and intentional tasks. They adopted four depth-of-processing manipulations that ranged from focussing study processing at the level of letters' shapes, to the level of syllables, to living/nonliving judgements levels to the level where words were studied in relation to the self. It was reported that depth-of-processing effects were not found in some intentional tests (participants had to identify words that were graphemically, phonemically or semantically similar to studied words) that required the deliberate conscious recollection of studied items. Priming in the conceptual incidental test of general knowledge required deeper processing at study whilst the shallower studied conditions were sufficient for priming to occur in the incidental perceptual test. But, contrary to the prediction of the TAP approach, an intentional perceptual test of graphemic cued-recall showed depth-of-processing effects and this effect was not found in the incidental version of this task. However, four tests that can be classified as conceptual did show a depth-of-processing effect. Challis et al. (1996) argue that these findings on depth-of-processing effects on memory tests cannot be explained by simple incidental/ intentional or perceptual/conceptual dichotomies. They instead prescribe that there is a need to specify the types of information activated at encoding, the type of information required by each test and how encoding and retrieval processes are governed by task demands.

There is considerable less work on depth-of-processing effects in the word association task. Experimental data on depth-of-processing effects in associations tasks derives primarily from studies involving stem-completion for new associations. A series of studies conducted by Graf and Schacter (1985, 1987; Schacter & Graf 1986, 1989) aimed to analyse the learning of new associations. As reported above, this paradigm requires participants to study unrelated word-pairs and, at test a word-stem is presented together with the paired word from the study phase, or with some other unrelated word. When the studied pair is reproposed at test, more target completions are made than when the new pairing is proposed, attesting to the learning of a new association, but this occurs only following elaborative study processing (Graf & Schacter 1985; Schacter & Graf, 1986). Therefore, priming of new associations is obtained when word-pairs are encoded elaboratively and is absent following shallower processing.

There are also though a few studies of word association which do not involve the more perceptual incidental task of stem-completion. This test requires participants to think about the meaning of the cue words in order to enable them to generate an associate of this word, so according to the processing approach performance should benefit from encoding tasks that promote meaningful processing. Instead, according to the systems approach, as retrieval is involuntary it should dissociate from voluntary retrieval. There are some reports (e.g., Schacter & Whitfield, 1986; Weldon & Coyote, 1996; Carlesimo, 1994) in which performance on the word association task exhibits a depth-of-processing effect. Schacter and Whitfield (1986), for example, showed that with unfamiliar pairing of two words a depth-of-processing effect was found in the word association test. However there are at least three reports in the literature that do not report an effect of conceptual elaboration in the word association task (Schacter & McGlynn, 1989; Vaidya, Gabrieli, Keane, Monti, Gutierrez-Rivas, & Zarella, 1997, Brooks, Gardiner, Kaminska, & Beavis (in press). Schacter and McGlynn (1989) found that performance in the incidental version of the word association task, when strongly related word-pairs or idioms are studied, was independent of a depth-of-processing manipulation. This manipulation instead had a significant effect on intentional cued-recall. Vaidya et al. (1997) also found no effect of elaborative processing at encoding for the word association task when words were strongly related.

These findings of a lack of a depth-of-processing effect on an incidental conceptual memory measure are theoretically very important because they are counterintuitive in the context of the processing framework. The findings go some way to support the emphasis proposed within the systems framework on the involuntary/voluntary dichotomy. Furthermore, the findings can be related to the dissociations found between tests in comparing some clinical populations, such as amnesic and schizophrenics, with normals. The dissociation within incidental word association tests between priming of strongly related and priming of weakly related words, show that the operations that mediate conceptual priming are dependent on the type of representations associated with strongly and weakly related words. On a related issue, studies carried out by Cabeza (1994) show that the type of processing carried out at encoding is crucial in modulating priming magnitudes. In Cabeza's (1994) study participants processed words by thinking in which category they belonged or by producing word associates. An advantage of the processing of category information was found for a category-exemplar-generation task but not for a word association task. By contrast, an advantage of the encoding of associative information was found in the word association task over the category exemplar generation task. This study emphasises the role of encoding operations in modulating priming expression. This point will be returned to in the last chapter in this thesis.

As depth-of-processing effects are used as marker of conceptual processes being in operation at retrieval, findings of a lack of depth-of-processing effects in tasks that have been in other cases classified as conceptual incidental tests, requires some explanation. In this thesis, Chapters 3 to 6 examine in greater detail depth-of-processing variations and their interaction with incidental retrieval in the word association task, with particular attention placed on the type of information that is encoded.

1.7 Depth of Processing, Conceptual priming and Familiarity

Conceptual priming has been compared and equated (e.g., Toth, 1996) to processes in recognition memory that are associated with the phenomenological feeling of familiarity. Dual process theories of recognition memory (e.g., Mandler, 1980; Jacoby, 1991) postulate the existence of two processes that contribute to recognition memory. One process is associated with the conscious recollection of the episode when learning took place. The other process is associated with a feeling of familiarity without conscious recollection of details of the study episode.

Originally, the phenomenon of familiarity was hypothesised to be perceptually based because it was affected by manipulations of the surface characteristics of the material to be recognised, and it was therefore compared to perceptual involuntary memory (e.g., Jacoby & Dallas, 1981). However, recent findings show perceptual effects on a variety of measures that are believed to reflect recollective processes and conceptual effects on a variety of measures that are believed to reflect familiarity-based processes. (Dewhurst & Conway, 1994; Mantyla, 1997, Rajaram, 1996; Toth 1996; Wagner, Gabrieli, & Verfaellie, 1997). Consequently, some authors such as Toth (1996) have now proposed a link between familiarity and conceptual priming.

The suggestion is that familiarity and conceptual priming share the same processing component. In particular, Toth (1996) argued that familiarity is not perceptually based and can be affected by conceptual manipulations in the same way that conceptual priming is. Toth (1996) provided some evidence to this effect by showing that measures of familiarity are affected by depth of processing of the material to be recognised. However, this result is isolated evidence of conceptual effects, and uses only one measure of familiarity. Toth (1996) adopted a speeded recognition technique (see Chapter 2) to isolate recognition contributed by a familiarity process from recognition accompanied by recollection as the two operations were believed to have different temporal properties (recollection being slower than a fast acting familiarity).

When a first person approach is used to measure recollection and familiarity, depth-of-processing effects on the familiarity measure are not reported (e.g., Gardiner, Java, & Richardson-Klavehn, 1996; Gardiner & Java, 1990; Gregg & Gardiner, 1994; Rajaram, 1993). This technique, introduced by Tulving (1985) and developed by Gardiner (1988), relies on participants reporting their phenomenological state of awareness when recognising an item as previously studied (for a review, see Gardiner & Richardson-Klavehn, 2000). Although the Remember/Know paradigm was developed to understand states of conscious awareness associated with the episodic and semantic systems, Remember and Know judgements have often been interpreted as measure of recollection and familiarity in recognition tasks (e.g., Gabrieli, 1998; Toth, 1996, Hirshman & Lanning, 1999). When a participant can consciously recall some aspect of the episode during which the learning took place they are instructed to make a "Remember" judgement. When participants experience only a sense of familiarity in the absence of recollection of any aspect of the encoding episode, they are instructed to make a "Know" judgement (see Gardiner, Ramponi, & Richardson-Klavehn, 1998).

To amplify our understanding of conceptual priming the hypothesised link between familiarity and conceptual priming deserves further exploration. This will constitute the first line of enquiry of this thesis. The aspect that will be investigated further is whether the evidence for conceptual effects on familiarity, as described by Toth, is on firm ground. In particular, considering the previous reports of a lack of conceptual effects on measures of familiarity (as indexed by Know responses) depth-of-processing effects on familiarity as observed by Toth (1996) will be investigated further by adopting a combination of Toth's methodology and Remember and Know responses.

1.8 Retrieval Volition, Conscious Awareness and Test Contamination

The main argument put forward in favour of the PDP is that it constitutes an advantage over the retrieval intentionality criterion when a variable is found not to dissociate between performance on the intentional and incidental retrieval tasks. The main evidence that intentional and incidental test performance dissociates comes from reports that some manipulations such as depth of study processing have no effects on incidental retrieval but have an effect on intentional retrieval. However, there is growing evidence (see Brown & Mitchell, 1992; Challis & Brodbeck, 1992) of parallel effects on involuntary and voluntary retrieval of conceptual manipulations that were considered to dissociate the two tests. Depth-of-processing effects on incidental tests, can then be interpreted as evidence of contamination of the incidental test from an intentional retrieval strategy (Reingold and Toth, 1996; Toth and Reingold, 1996; Toth, Reingold and Jacoby, 1994). The PDP was developed to eliminate the effects of contamination of the incidental test and evidence of this is derived from the lack of depth-of-processing effects on the estimate of automatic retrieval and by the presence of the effect on the estimate of controlled retrieval.

Richardson-Klavehn and Gardiner (1998) have argued that depth-of-processing effects in incidental tests do not necessarily entail contamination from a voluntary strategy. Richardson-Klavehn and Gardiner (1998) investigated the hypothesis that depth-of-processing effects in incidental tests is related to curtailment of lexical processing in the study phase and not to contamination of a voluntary retrieval strategy. In this study, in addition to a phonemic and a semantic task, a graphemic task was employed. The graphemic task involved counting the enclosed spaces within the letters of studied words. A level-of-processing effect was found in the incidental task of stem completion if retrieval following graphemic and semantic study processing was compared. Instead, following semantic and phonemic study processing, a level-of-processing effect was found only in the intentional test of stem cued-recall, but not in the incidental test. The results supported the hypothesis that level-of-processing effects on priming can be attributed to reduced lexical processing of studied words and did not entail a contamination of a voluntary retrieval strategy. Like the Challis et al. (1996) study, the Richardson-Klavehn and Gardiner (1998) draws attention to the importance of the orienting task in the study phase in obtaining conceptual elaboration effects in incidental tests and warn us against concluding in favour of a contamination hypothesis.

The issue of contamination constitutes a major problem in the study of conceptual involuntary retrieval. Dissociations between the tests are difficult to reveal, and variables that have traditionally dissociated involuntary and voluntary retrieval, such as depth of processing, are found, in most cases as reviewed above, to have a marked effect in incidental conceptual tests as well as in intentional tests. Advocates of the use of the PDP would argue that conceptual priming shows effect of conceptual manipulations because the test is subject to contamination. In this thesis the voluntary contamination hypothesis of conceptual incidental tests is addressed further. An in depth analysis of the conditions under which conceptual manipulations effects are found and those in which such effects are not found, will put us in a position to judge the possibility of contamination of incidental conceptual tests.

Furthermore, taking into consideration the limitations of the PDP in confusing retrieval volition with conscious awareness (Richardson-Klavehn & Gardiner, 1995; Richardson-Klavehn, Gardiner, & Java, 1994, 1996), it seems an important step to try to assess the extent to which conceptual incidental retrieval is accompanied by conscious awareness. An attempt at such assessment will be made in this thesis.

1.9 Overview of this Thesis

The overall aim of the thesis is to further understanding of the nature of conceptual priming. In particular, the thesis focuses on trying to correctly interpret the theoretical implications of the effects of depth of encoding processes on conceptual priming. Two theoretical interpretations of encoding processing effects on conceptual priming have emerged in the literature that are of interest here. In one, depth-of-processing effects have been interpreted as undermining the voluntary/involuntary distinction in favour of the conceptually driven and data-driven distinction. In the other, depth-of-processing effects have been interpreted as a sign of contamination of incidental tests by voluntary retrieval strategies. The merits of the theoretical interpretations are discussed in relation to the empirical findings reported in this thesis. The empirical work in this thesis first begins with an attempt to show an absence of depth-of-processing effects on familiarity which has been linked to conceptual priming (Toth, 1996). Then further empirical work tries to identify the circumstances in which depth-of-processing effects are absent in conceptual priming and in so doing it provides evidence against a process distinction between tests and against a contamination hypothesis.

In Chapter 2, the focus will be on investigating Toth's claim that familiarity behaves in a similar way to conceptual priming in the way that it is affected by conceptual manipulations. In view of reports of a lack of depth-of-processing effects on some measures of familiarity, Toth's technique of speeded recognition for isolating familiarity is tested in conjunction with Know responses measures of familiarity to further analyse the origin of the discrepancy between the two measures.

In Chapter 3, depth-of-processing effects in the conceptual incidental test of word association are investigated further by adopting a wider range of processing depths. Furthermore, a tentative supposition may be drawn from the literature review about depth-of-processing effects on the incidental version of the word association task: There seems to be a dependency between depth-of-processing effects and the level of association between word pairs. This dependency is placed on firmer empirical footing by analysing a more comprehensive range of association strengths between pairs in the incidental and intentional form of the word association task.

In Chapter 4, an attempt is made to advance understanding of performance on conceptual incidental tests in a population of older adults. The literature review revealed conflicting evidence on whether conceptual incidental retrieval is intact or impaired in older adults. In the experiment described, manipulations of association strength and depth of processing on the incidental and intentional word association task are combined with an age manipulation.

In the experiments reported in Chapter 3 and 4, a different effect of elaborative study processing on the incidental test was obtained for different association strengths. However, this effect may have been related to differences in baseline completions for the pairs of different association strength. In Chapter 5, the issue of different completion baselines for strong and weak associates is investigated by equating baselines but not the strength of the association, measured by a different criterion.

Finally, in Chapter 6, the hypothesis that, in certain circumstances, the incidental test of word association taps perceptual rather than conceptual processes/systems, thus explaining the lack of depth-of-processing effects in this test in some instances, is investigated. A modality manipulation is employed to this effect. At the same time, an attempt is also made to analyse the conscious correlates of retrieval in this incidental test. General conclusions are drawn in Chapter 7.

Chapter 2

Conceptual Processing and Recognition

Overview of Chapter 2

In this chapter, the hypothesis of a link between familiarity and conceptual priming, as suggested by Toth (1996), is investigated. Dual process theories of recognition memory (e.g., Mandler, 1980; Jacoby 1991) posit the existence of two independent processes that contribute to recognition. One process is said to mediate recognition associated with the conscious recollection of the episode during which the information was acquired. The other process mediate recognition that is accompanied by an experience of familiarity. Originally, the phenomenon of familiarity was believed to be perceptually mediated and was compared to perceptual involuntary memory (Mandler, 1980; Graf & Mandler, 1984). It was hypothesised (e.g., Jacoby & Dallas, 1981) that operations tapped by perceptual incidental tests and operations that mediated familiarity shared the same process. However, recently findings have been reported that purportedly show conceptual effects on familiarity based processes (Toth, 1996). As a result, authors such as Toth (1996) have proposed a link between familiarity and conceptual priming. Toth (1996) adopted the technique of speeded recognition to isolate the familiarity from the recollection process and demonstrated a depth of study-processing effect on measures of familiarity, suggesting a link to conceptual priming. Remember and Know judgements (Tulving, 1985; Gardiner, 1988) have often been interpreted as reflecting the phenomenological experience associated with recollection and familiarity (see, Gardiner & Richardson-Klavehn, 2000). Considering previous reports of conceptual manipulation of study processes found to affect remembering but not knowing (e.g., Gardiner, 1988; see also Gardiner, Java, & Richardson-Klavehn, 1996), a puzzle is left about the relationship between phenomenological state of awareness and the process of recollection and familiarity. Depth-of-processing effects on measures of familiarity are investigated further by combining the speeded recognition technique with Remember and Know judgements. It was found that familiarity, as measured by Know judgements, did not show conceptual effects. The lack of effect of conceptual manipulations on the measure of familiarity does not necessarily imply that the link between familiarity and conceptual priming is to be rejected. In fact, conceptual manipulation effects on conceptual priming measures are also not consistently found. This is the subject of investigation of Chapter 3.

2.1 Introduction

Some theories of recognition memory converge in proposing that when participants attempt to solve a recognition task, *two distinct* processes are called into operation. These theories are grouped under the umbrella term of dual process theories (Jacoby, 1991; Jacoby & Dallas, 1981; Mandler, 1980, 1991). They contrast with single process theories, where the argument is in favour of a simple unitary model (e.g., Gillund & Shiffrin, 1984) and models that assume differences only in trace strength and response criteria (e.g., Hirshman & Master, 1998).

According to dual processes theories of recognition (Juola, Fischler, Wood, & Atkinson, 1971; Atkinson & Juola, 1974;; Jacoby & Dallas, 1981; Mandler, 1980) two distinct mnemonic processes, identified by the labels of recollection and familiarity, operate during recognition. According to Mandler's (1980) dual process theory, the two recognition processes are separate and additive. The recollective process was hypothesised to mediate a recall-like operation and was hence influenced by meaning. The familiarity process, instead, was proposed to involve the integration of mainly perceptual aspects of the study event. Juola et al. (1971) and Mandler (1980) proposed that any item presented in a test phase has an initial familiarity value: Items with a familiarity value above a certain criteria are classified as old and those below *another* criteria are classified as new. When the familiarity value happens to fall between the two criteria then a process of checking becomes necessary and participants are believed to mentally scan the set of items presented at study before producing an answer. This checking process is believed to take up extra time over recognition mediated by familiarity, therefore, the recollection process is associated with a longer duration than the familiarity process.

Dual process theorists initially concurred in proposing that the recollection process was sensitive to manipulations of conceptual processing as conceptual variables such as depth-of-processing manipulations were found to modulate recollection levels but not familiarity levels (Jacoby & Dallas, 1981). The process that mediated familiarity was instead observed to be sensitive to perceptual manipulations: The degree of similarity of surface characteristics between the study phase and the recognition phase was found to have an effect on measures of familiarity (Jacoby & Dallas, 1981, Jacoby & Hayman, 1987). Within Jacoby's (1983) dual process theory, the independent factor of recollection, which is equated to a *controlled* processes, is hypothesised to be influenced by conceptually driven processing and familiarity, which is equated to an *automatic* processes, is hypothesised to be mediated by data-driven processing. Jacoby and Dallas (1981) explain familiarity as resulting from perceptual fluency. More importantly, within dual process theories, it was further suggested that recognition and perceptual priming shared a common process of fluency and familiarity (Jacoby & Dallas, 1981, Mandler 1980, Graf & Mandler, 1984). Prior perceptual processing of a stimulus makes more fluent the later re-processing of that stimulus and this fluency is associated with a feeling of familiarity. Fluency was hypothesised to also mediate performance in perceptual incidental retrieval tasks.

One procedure, initially developed (Tulving, 1985) to measure episodic and semantic memory, has often been linked to the dissociation of the recollection and familiarity processes of recognition described within the dual process framework (for a review, see Gardiner & Richardson-Klavehn, 2000). In this procedure (Tulving, 1985, Gardiner 1988) participants are asked to distinguish between two subjective states of awareness in response to an item which is recognised. Recognition that is associated with the experience of the conscious recollection of some aspect of the episode when the given item was first encountered, is assigned a "Remember" judgement. Recognition in the absence of such phenomenological experience but associated with a feeling of knowing that the given item appeared in a previous encounter, is assigned a "Know" judgement. Remember and Know judgements were originally introduced by Tulving (1985) as respective indexes of autonoetic consciousness related to the episodic system and noetic consciousness related to the semantic system. However, Remember and Know judgements have also been interpreted as being directly related to the recollective and familiarity components of dual process theories (e.g., Gabrieli, 1998; Toth, 1996; Hirshman & Lanning, 1999; Yonelinas & Jacoby,1995).

One of the advantages of the Remember and Know paradigm is that it provides a direct measure of subjective states of awareness rather than these being inferred within more conventional paradigm. A number of variables have been found that dissociate remembering and knowing (for a review see Gardiner & Richardson-Klavehn, 2000). Some variables have been found to affect remembering but not knowing and other, although fewer, have been found to affect knowing but not remembering. Some other variables affect remembering and knowing in opposite ways. The presence of these dissociations would support some hypotheses that the two different phenomenological experiences express the operations of possibly separate systems (e.g., Tulving, 1985) or processes (e.g., Rajaram, 1993) or the differing experience is possibly an expression of separate representations. However, the technique is valid in itself as a way of identifying and describing subjective states of awareness without any commitment to the above theoretical positions. Conscious recollection, as measured by Remember judgements, has been found to be affected by conceptual manipulations at study, such as depth-of-processing manipulations and generate/read manipulations (Gardiner, 1988; Rajaram, 1996; Gardiner et al., 1996) when these manipulations had no effect on familiarity as indexed by Know responses. There is also some evidence that Know judgements are influenced by the manipulation of perceptual variables (Gardiner, Gawlick, & Richardson-Klavehn, 1994; Gardiner & Java, 1990; Gregg & Gardiner, 1994; Rajaram, 1996). On the basis of these findings, the main conclusion drawn by Rajaram (1996) was that conceptual manipulations selectively influence the recollective process of recognition memory as measured by Remember judgements. Instead, perceptual manipulations selectively influence familiarity judgements as measured by Know judgements.

The component captured by Know judgements, in a similar fashion to the familiarity process of dual process theories, was also linked to the component hypothesised to mediate performance in perceptual incidental memory tasks (Gardiner, 1988; Tulving, 1985). However, more recently it has been argued (Richardson-Klavehn, Gardiner, & Java, 1996; Gardiner & Richardson-Klavehn, 2000; see also Wagner, Gabrieli, & Verfaellie, 1997) that this link undermines the distinction between conscious and unconscious states of awareness that should be made between Know judgements and involuntary memory. When participants report a Know judgement they are aware of the temporal/spatial context of when the event was committed to memory as it is implied in the instructions. Knowlton and Squire (1995) also state that neuropsychological evidence argue against this link. They found that amnesic patients were impaired on both "Remember" and "Know" judgements on a recognition memory test. But, as amnesic patients have intact priming, it seems implausible to entertain the idea that the same processes could underlie priming and Know recognition responses. Furthermore, there are now a number of variables that have been found to have different effects on recognition responses accompanied by Know judgements and on perceptual involuntary memory. For example, word frequency has an effect on perceptual priming (e.g., Jacoby &, 1981) but has no effect on Know judgements in the presence of a marked effect on Remember judgements (Gardiner & Java, 1990; Gardiner, Richardson-Klavehn, & Ramponi, 1997; Strack & Forster, 1995).

It does not appear that methods used to isolate familiarity in intentional recognition are identifying the same processes that mediate perceptual priming. However, in the light of the newer distinction between perceptual and conceptual priming the hypothesis of this link could possibly be revived. In fact, as reviewed in Chapter 1, there is very little agreement on whether conceptual priming is impaired or intact in amnesic patients and there is hardly any evidence in respect of the phenomenological state of awareness associated with this form of retrieval. In this scenario, a link is plausible.

Recently, findings have been reported that show perceptual effects on recollective processes (e.g., Dewhurst & Conway, 1994; Rajaram, 1996) and conceptual effects on familiarity based processes (Mantyla, 1997; Toth, 1996; Wagner, Gabrieli, & Verfaellie, 1997). Jacoby and colleagues (Jacoby, 1991; Jacoby et al., 1993; Jennings & Jacoby, 1993; Toth, 1996) have recently argued that familiarity based recognition is sensitive to conceptual processing, and Wagner et al. (1997) argue that familiarity based recognition is more reliant on conceptual than on perceptual processes and is distinct from involuntary perceptual memory.

In light of the evidence of conceptual effects on measures of familiarity, Toth (1996) argues that memory for meaning-based processes support familiarity judgements and proposes a link between familiarity and conceptual priming. In this view, evidence for effects of conceptual variables on involuntary memory should be mirrored by conceptual effects in familiarity judgements.

As reviewed in the previous chapter, there is a substantial body of work on conceptual priming that shows generation (Blaxton, 1989; Java, 1996; Nyberg & Nilsson, 1995; Roediger & Srinivas, 1990) and depth-of-processing effects (Challis & Sidhu, 1993; Keane et al. 1997; Hamann, 1990; Mecklenbrauker et al., 1996; Srinivas & Roediger, 1990; Schacter & McGlynn, 1989; Schacter & Whitfield, 1986; Vaidya et al. 1998; Weldon & Coyote, 1996) on conceptual priming. Toth and Reingold (1996) argue that conceptual priming expresses memory for meaning-based processing initially engaged at encoding. If recognition and conceptual priming performance reflect common automatic processes, then the effects found in conceptual priming suggest the possibility of conceptually based automatic influences in recognition memory.

In Toth's (1996) study, the response signal procedure is adopted as a means to isolate the familiarity process from the recollection process. This procedure exploits the putative temporal properties of the familiarity and recollection processes. The assumptions of the procedure dictate that recognition mediated by familiarity has shorter latency than recognition mediated by recollection. The recognition responses based on familiarity can be isolated by requiring participants to produce their recognition responses within a very short time limit. The assumption of the procedure is that the bulk of the responses produced at this shorter time limit are mediated by the familiarity process. By comparing the response patterns obtained at the shorter time limit with the response patterns at a longer time limit (when the recollection process begins to mediate recognition responses) inferences can be drawn about the nature and behaviour of the two recognition processes.

In order to ensure that the speeded recognition procedure isolated the two components, Toth (1996) applied a modality manipulation. Toth (1996) found that modality had an effect on recognition responses carried out at the short time deadline but had no effect on recognition performance at the longer time deadline. The presence of the modality effect at the shorter deadline led to the preliminary conclusion that recognition judgements that took place at the short deadline were mainly based on familiarity. Toth (1996) then reports that the predicted depth-of-processing effect was found for the responses carried out at the long delay. However, more importantly, this effect was also found in recognition performance for the short delay where supposedly recognition is based mainly on familiarity. This led Toth (1996) to conclude that familiarity judgements are also modulated by conceptual manipulations at study.

2.2 Experiment 1

In the experiment the effects of depth of processing on familiarity measures are investigated by comparing measures of recollection and familiarity derived from a speeded recognition procedure with those derived from the Remember and Know procedure. A Guess response was also introduced to constrain and increase the accuracy of Know judgements (Gardiner et al., 1996, 1997; Gardiner & Conway, 1999). In the experiment, participants were trained to make their recognition responses within the same time limits as those adopted in Toth's (1996) experiment (500ms and 1500ms). In addition, following a positive recognition response participants were asked to report a Remember judgement when they consciously recollect some aspect of the study episode, and Know judgements when they experienced a strong feeling of knowing that they came across the item recently. In the case of the absence of any of these two states of awareness, participants were instructed to report their recognition response as a guess. However, participants were discouraged from guessing during the speeded recognition stage. By combining the speeded recognition procedure with subsequent subjective reports in the form of Remember, Know and Guess judgements, more direct conclusions can be drawn on the phenomenal experience that accompany recognition performance rather than this experience being inferred from the timing of the responses. In fact, not all the evidence points in the direction of a fast acting familiarity and a slow acting recollection process. There is some evidence that recognition decisions accompanied by a recollective state of awareness are somewhat faster than those recognition decisions accompanied by a Know judgement (Dewhurst & Conway, 1994). The use of the two procedures in conjunction can elucidate further the relationship between remembering and knowing and the component of recollection and familiarity as conceived within dual process theories of recognition.

The following experiment was predicted to replicate Toth's findings that recognition performance is curtailed at the shorter deadline in comparison to the longer deadline and a depth-of-processing effect is observed at both deadlines. More importantly though, the experiment investigated the relationship between the speeded recognition measures of familiarity and recollection and the state of awareness reports indexed by Remember and Know judgements. According to Toth's (1996) hypothesis, if Know responses are viewed as measures of familiarity, a larger number of Know responses should be reported following the shorter deadline than the longer deadline and these responses should also be expected to show an effect of the conceptual manipulation. However, considering previous reports of a lack of effects of depth of processing on measures of familiarity as indexed by Know responses (e.g. Gardiner, Java, & Richardson-Klavehn, 1996), depth-of-processing effects on these responses may not manifest.

2.3 Method

2.3.1 Participants, Design and Materials

The participants were 32 students from City University, London and they were either paid for their participation or participated for partial fulfilment of course credits.

Depth of processing was manipulated within participants and response signal delay was manipulated between participants. All participants reported Remember , Know and Guess responses.

Two study Lists, A and B, of 48 two-syllable common words (drawn from the Toronto pool of two-syllable words) were constructed (see Appendix 2.1). In the study phase, half of the participants studied List A and the other half studied List B. The depth of processing variable was manipulated within participants. Half of the participants that studied List A did a semantic orienting task for the first 24 words and a phonemic orienting task for the remaining 24 words. The second half of the participants who studied List A did a phonemic orienting task first and a semantic orienting task second. The same split was adopted for participants who studied List B.

In the training phase, where participants were accustomed to the speeded response procedure, a set of 20 four-letter words and 20 four-letter non-words were used. (See Appendix 2.2.)

In the recognition phase, participants were presented with 96 words obtained by combining List A and B. For the participants that received List A, List B functioned as the distracter list and vice-versa for the participants that saw List B at study. The response signal delay variable was manipulated between participants. Participants were randomly assigned to either a short response signal delay (500 ms vs. 1500 ms) or a long response signal delay. After their recognition responses, participants reported Remember, Know and Guess responses.

All stimuli were presented on an Apple Macintosh PowerBook. programmed in the HyperCard environment The computer recorded participants' responses and the latencies associated with the responses.

2.3.2 Procedure

Each participant was tested individually. Participants underwent three phases: a study phase; a training phase, where participants were accustomed to the speeded responding procedure; a recognition phase.

Study phase

In the study phase, participants were instructed (see Appendix 2.2) for one half of the words to rate the easiness of generating semantic associates on a 5 point scale (1=very easy and 5=very difficult). For the other half, they had to rate the easiness of generating words that rhymed with the stimulus words on the same 5-point scale. For both judgements tasks, 5 buttons labelled from 1 to 5 appeared next to the target word and participants indicated their response by pressing any of the 5 buttons. The words appeared on the screen for one second, but participants were allowed to take any length of time to make their judgements. As the participants pressed any of the buttons on the rating scale, the next word was presented on the screen. In addition to the 40 target words in the study list: three filler words were presented as the first three words of the semantic task and three other fillers were presented first in the non-semantic task.

Training phase

Following Toth (1996), the study phase was followed by a training phase where participants were trained in making a lexical decision within a time limit imposed by the experimenter. The same time cut-off points chosen by Toth (1996) were adopted here. In the short delay condition, participants had to make their lexical decision within 500 ms. In the longer delay condition, the lexical decision had to be made within 1500 ms.. Participants were presented with either a four-letter word or a four-letter non-sense word. Participants had to carry out a lexical decision task and were instructed (see Appendix 2.3) to decide whether the item they saw on the screen was a word or not. A set of forty items (20 word and 20 non-words - see Appendix 2.2) was presented to the participant. The appearance of the item was prompted by a set of signalling arrows (>>> <<<) that appeared in the middle of the screen surrounding the location where the target item would appear after 1 second. According to their assigned condition, participants had either 500ms or 1500ms to inspect the target item before they were required to respond. Participants were prompted to make their response as soon as a row of asterisks appeared beneath the target item and this response should occur within 400ms following the appearance of the row of asterisks.

Participants made their response by pressing one of two buttons on the keyboard labelled "Yes" and "No". They had to press the "Yes" button with the index finger of their left hand and the "No" button with the index finger of their right hand. The time lag between the appearance of the asterisks and the participants depressing one of the two keys was recorded by the computer. As the participants made the response, the screen was cleared and a dialogue box reported participants' reaction time of their last response with feedback on their performance. If participants' responses were faster than 50 ms, then following Toth (1996), they were shown the message "too fast try and wait for the row of asterisks" next to their response time. If the response was between 50ms and 400 ms, they were shown their response time followed by the message "good". If participants took longer than 400 ms, they were shown their response time and the message "try faster". The feedback message appeared on the screen for two seconds. After one second gap, the prompting arrows for the next item were presented. In order to encourage participants to respond within the time boundaries, participants were told that their hit rate (i.e., how many times they managed to stay within the time boundaries) would be displayed at the end of the test. The participant's aim was to achieve the highest possible score.

Recognition phase

The recognition phase followed immediately after the training phase. Participants were told that this time they would be presented with a set of words. Some of the words that they would see would be the same as the words they saw in the study phase and some would be new words. (Participants were informed that none of the words they would see in this phase was the four letter words that were used in the training phase). For each word, participants had to say whether they recognised the word as one of the words they saw before in the study phase. Participants were told that, just as in the training phase, they had a very short time to inspect the word and they had to report their recognition response very fast, between 50ms and 500 ms, as soon as they saw the row of asterisks. The presentation procedure was identical to the procedure in the training phase, with the difference that items presented were this time the 96 words of the recognition list. In addition to the 96 target items, participants initially carried out the task with 12 filler words. Of the twelve filler words, 6 words were the same as the filler words presented at study. These first 12 words were presented to the participants, in a random order, in the first instance as a pilot study showed that the first few responses with this procedure were very slow. Therefore, the times taken by the participant in giving their recognition response for these first *filler* words, were not analysed. The response times for the target words were recorded by the computer. Feedback to the participants was administered in the same way as in the training phase. However, this time, as the feedback box disappeared, three buttons appeared on the screen. The buttons were labelled "Remember", "Know" and "Guess". At the beginning of the test phase participants were given extensive instructions (see appendix 2.5) on how to determine Remember and Know responses following positive recognition. Written instructions were supplemented by oral instructions to ensure an understanding on behalf of the participants about the state of awareness they should experience when reporting these responses. Participants reported their subjective response by pressing the corresponding button.

At the end of the recognition phase, participants' accuracy in assigning state of awareness judgements, was further checked by selecting some random responses and asking the participant to describe their state of awareness when they recognised the word.

2.4 Results and Discussion

Following Toth (1996), the statistical analyses were carried out only on responses that occurred within 50 ms and 500 ms after the response signal, whether the signal was after 500 ms or 1500 ms. Toth (1996) proposed that after 500 ms, responses reflected a preponderance of recognition judgements accompanied by conscious recollection. The responses of 91% of participants' were within the time boundaries stated above (this compares to Toth's rates at 92%) and these were the responses included for analysis.

Mean proportions of recognition broken down in Remember, Know and Guess judgements are reported in Table 2.1. Analyses were performed on uncorrected recognition data (overall hits) and on corrected recognition data (hits minus false alarms). Separate analyses were carried for each of these two sets of data. The analyses over the two sets of data yielded identical patterns hence only results on uncorrected recognition data are reported.

TABLE 2.1

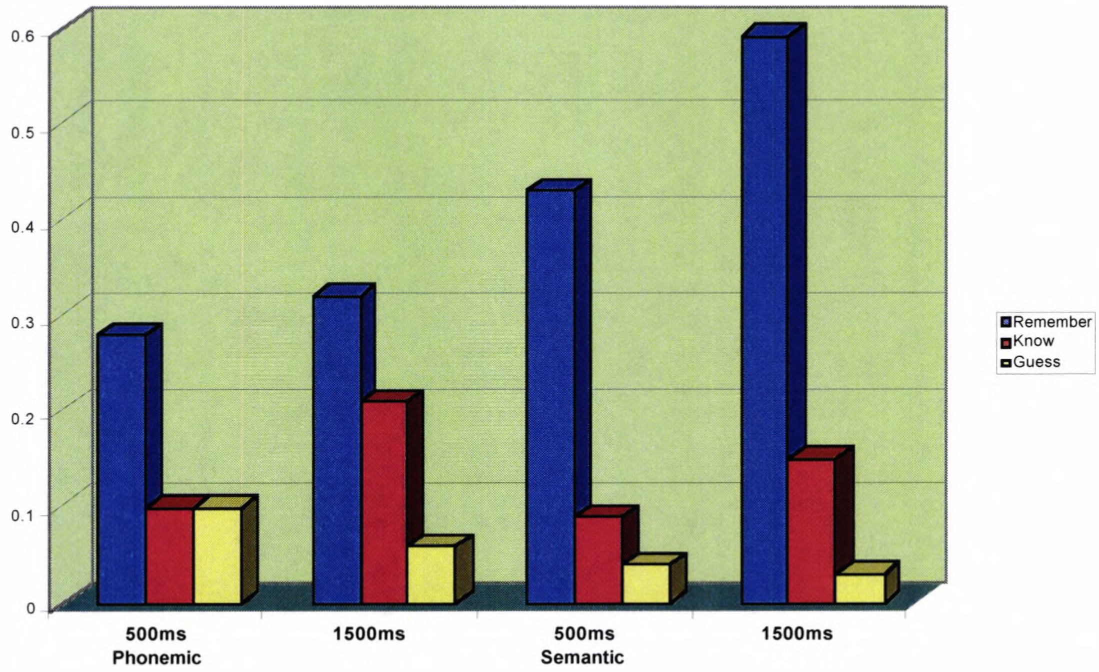
MEAN PROPORTIONS (M) AND STANDARD ERRORS (SE) OF REMEMBER, KNOW, AND GUESS RESPONSES AS A FUNCTION OF DEPTH-OF-PROCESSING, AND RESPONSE DEADLINE.

	Studied								*Unstudied*			
	Phonemic				***Semantic***							
	500ms		*1500ms*		*500ms*		*1500ms*		*500ms*		*1500ms*	
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Remember	.28	*.06*	.32	*.04*	.43	*.06*	.59	*.04*	.01	*.00*	.02	*.01*
Know	.10	*.01*	.21	*.03*	.09	*.02*	.15	*.03*	.05	*.01*	.07	*.02*
Guess	.10	*.03*	.06	*.02*	.04	*.01*	.03	*.01*	.06	*.01*	.04	*.01*
Tot.	.48	*.05*	.59	*.05*	.56	*.05*	.77	*.03*	.12	*.02*	.13	*.02*

Guess responses to studied compared to unstudied words did not significantly differ [$t = -.849$, $p=.402$] and therefore these judgements are omitted from overall analyses. A 2x2x2 mixed ANOVA was carried out with depth of processing (semantic vs. phonemic) as the within participant factor and response signal delay as the between participant factor (500 ms vs. 1500 ms). Remember and Know responses were also treated as a within participant factor in order to allow statistical comparison between the measures in relation to the speeded recognition measure and depth of processing.

The data show a significant main effect of response signal delay [$F_{(1,30)} = 8.48$, $p = .007$] : Significantly more recognition responses were obtained following the 1500 ms inspection time over the 500ms inspection time. A significant main effect of depth of processing [$F_{(1,30)} = 35.04$, $p < .001$] was also reported with semantic processing being associated with a larger number of recognition responses. Participants also reported significantly more Remember than Know responses [$F_{(1,30)} = 47.84$, $p < .001$]. The interaction between response signal delay and depth of processing was not significant [$F_{(1,30)} = 1.66$, $p = .208$] replicating Toth's (1996) finding of a depth-of-processing effect at both signal delays. The conclusion drawn by Toth (1996) at this stage was that as responses at the shorter delays are mainly based on familiarity, familiarity is modulated by depth of processing. The interaction between signal delay and response type (Remember or Know) was, though, not significant [$F_{(1,30)} = .030$, $p = .864$], showing that Remember and Know responses were not differentially affected by the signal delay. This result questions the assumption that recollection based responses are truncated by the shorter signal delay more so than familiarity based responses, at least as measured by Remember and Know judgements. The interaction between depth of processing and response type was instead significant [$F_{(1,30)} = 29.83$, $p < .001$]. Further analyses qualified this interaction as the result of a significant depth-of-processing effect on Remember responses [$F_{(1,30)} = 47.00$, $p < .001$] but not on Know responses [$F_{(1,30)} = 1.99$, $p = .168$]. These results tie well with the past literature on Remember and Know judgements showing an effect of depth of processing only on Remember responses and no effect on Know responses. The three way interaction between signal delay, depth of processing and response type only approached significance [$F_{(1,30)} = 3.52$, $p = .07$]. The curtailment of responses at the shorter signal delay was less marked for the recollection based responses for the words studied with the phonemic orienting task, as can be seen on Figure 2.1.

FIGURE 2.1.
EXPERIMENT 1: REMEMBER, KNOW AND GUESS RESPONSES AS A FUNCTION OF STUDY TASK AND RESPONSE DEADLINE



In summary, Toth's (1996) findings of a depth-of-processing effect at the short delay were replicated. However, Remember and Know measures indicate that the location of such effect was primarily in the responses accompanied by Remember judgements, even at the shorter delay. Furthermore, curtailment of recognition performance, as imposed by the shorter deadline, contrary to what was previously assumed, had a similar effect on recognition responses accompanied by both Remember and Know judgements.

One last point should be made about the relationship between Remember and Know judgements and the PDP (see Chapter 1) for separating the familiarity and recollection component of recognition memory. Jacoby and colleagues (e.g., Jacoby, Yonelinas, & Jennings, 1997; Jacoby, Jones, & Dolan, 1998) have argued that Know judgements are erroneous estimates as they do not take into account the independence of the two processes that mediate recollection and familiarity. However, Jacoby and colleagues (Jacoby, Yonelinas, & Jennings, 1997) have argued that measures from the Remember and Know procedure can be brought in line with estimates of recollection and familiarity as measured by the PDP. With an arithmetic transformation of Know response proportions, the familiarity estimate can be boosted in order to take into account those situations whereby familiarity and recollection act simultaneously. According to this Independence Remember /Know model (Jacoby, Yonelinas, & Jennings, 1997) the proportion of Know responses are divided by one minus the proportion of Remember responses. The means of the above estimates for the current data are reported in Table 2.2. An inspection of the table shows that, even these estimates of familiarity do not help in sufficiently boosting familiarity levels, in particular at the shorter signal delay. In particular familiarity, which should remain constant according to this approach, increases with delay even more than recollection. Furthermore, a significant depth-of-processing effect was not found with these estimates either. Paired comparisons between the familiarity estimate for the phonemic condition and the familiarity estimate of the semantic condition show a non significant difference at the short delay ($t = -.68$, $p = .51$) and at the long delay ($t = -.70$, $p = .49$)

TABLE 2.2

RECOLLECTION AND FAMILIARITY ESTIMATES FROM THE IRK MODEL, AS A FUNCTION OF STUDY TASK AND RESPONSE DEADLINE.

	Phonemic		***Semantic***	
IRK estimates	*500ms*	*1500ms*	*500ms*	*1500ms*
Recollection	.28	.32	.43	.59
Familiarity	.14	.31	.16	.36

The problem of the relation between the two procedures has been discussed at length (Jacoby et al., 1997; Richardson-Klavehn et al., 1996; Reingold & Toth, 1996). Here it suffices to say that there is a convergence on depth-of-processing effects on measures from both models.

There is also a possible suggestion that depth-of-processing effects were not found in Know judgements because of ceiling effects in overall recognition at the longer signal delay of words that were studied under a semantic orienting task. This issue is addressed in Experiment 2.

2.5 Experiment 2

The second experiment is aimed at putting the findings obtained in the first experiment on firmer ground by attempting to reduce overall recognition to ensure against ceiling effects. To achieve lower performance, the time interval between the study and the recognition phase was increased to a few days. Furthermore, the different conceptual study manipulation of generating versus reading at study is adopted as it provides a further test of conceptual effects on responses accompanied by a feeling of familiarity.

2.6 Method

2.6.1 Participants, Design and Materials

The participants were 40 other students from City University in London and they were either paid for their participation or participated for partial fulfilment of course credits. The generate/read variable was manipulated within participants, instead signal delay was varied between participants. In the generate task, participants had to generate words following the presentation of the target's first letter together with a sentence that defined the target (see Appendix 2.7). In the read task, participants simply had to read the target words on the screen. Two lists, A and B, of 40 words each were constructed so that each word could be defined by a short sentence. Participants studied one of the two lists. Generate/read task order was counterbalanced so half of the participants did a generate task for half of the word and a read task for the other half. The order of the task was reversed for the other half of the group. The material used in the training phase was identical to the material used in experiment 1. The recognition list consisted of the List A and B combined. Participants had to first decide whether they recognised the word and then, only following positive recognition, they had to assign a Remember, Know or Guess judgement.

2.6.2 Procedure

As in Experiment 1, this experiment comprised three phases, a study, a training, and a recognition phase. During the study phase, in the generate task participants were told that they would first see a sentence on the computer screen which defined a word. The first letter of the word was also presented on the computer screen below the sentence. The participant's task was to say the word aloud once identified. This was done for the experimenter to check that the participant generated the correct word. If the participant could not identify the correct word, the experimenter supplied the word. This happened only in rare occasions. The participant paced the task by pressing a "next" button as soon as the word was identified. Then the sentence and first letter of the next target word was presented. The presentation of the words was in a fixed order for all the participants. In the read task, participant simply read the words presented on the screen. To see the words participants had to press the button "next" after they read the word.

Participants were then dismissed and asked to come back for a second section after a variable interval of no less than 3 days and no more than 7 days, at their convenience. When participants came back, they first did the training task where they had to carry out the lexical decision task of experiment one, where they made fast decisions on the status of items, whether they were words or non-words. As experiment one, half of the participants were trained with the 500 ms signal delay and the other with the 1500 ms delay. The procedure was identical to the training task in Experiment 1.

The recognition phase followed after the training phase. As in experiment 1 participants had to make a fast decision, after 500 ms or 1500 ms delay, on whether they recognised the word on the screen as one of the earlier presented words. Given the difference in retention interval between experiment 1 and 2, in a pilot study it was found that people tended to adopt a very loose criteria when making their recognition responses, tending to report a much higher false alarm rate. Hence, in this experiment accuracy was emphasised, participants were instructed not to press the "Yes" button unless they felt they were absolutely sure. Due to the difficulty imposed by the short time interval allowed for their responses, they were told that the "No" button should be their default button. The response time was recorded by the computer and feedback on response time was given to the participant in the same format as in experiment 1. After producing a positive recognition response, participants had to press one of three buttons to indicate their Remember, Know or Guess judgements. At the end of this section, participants were asked to justify some of their recognition responses to unsure that they correctly followed the Remember, Know and Guess instructions.

2.7 Results and Discussion

As with the previous experiment, the analyses were carried only on responses that occurred within 50 ms and 500 ms after the response signal, whether the signal was after 500 ms or 1500 ms. Recognition responses of 89% of participants' were within the time boundaries stated above. These were the responses included for analysis. Mean proportions of recognition responses broken down in Remember, Know and Guess judgements are reported in Table 2.2.

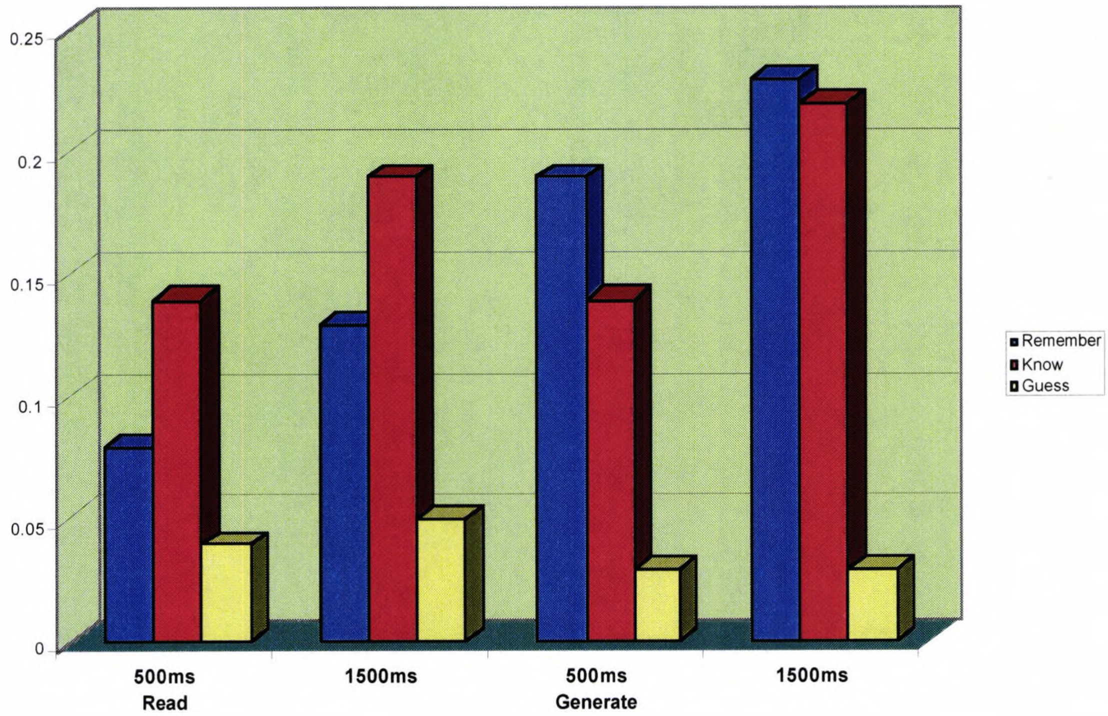
TABLE 2.3
MEAN PROPORTIONS AND STANDARD ERROR (SE) OF REMEMBER, KNOW, AND GUESS RESPONSES AS A FUNCTION OF GENERATING VS. READING AND RESPONSE DEADLINE.

	Studied											
	Read				***Generate***				*Unstudied*			
	500ms		*1500ms*		*500ms*		*1500ms*		*500ms*		*1500ms*	
	Mean	*SE*	Mean	*SE*	Mean	*SE*	*Mean*	*SE*	Mean	*SE*	Mean	*SE*
Remember	.08	*.02*	.13	*.02*	.19	*.04*	.23	*.04*	.03	*.01*	.02	*.01*
Know	.14	*.03*	.19	*.02*	.14	*.03*	.22	*.03*	.09	*.02*	.08	*.02*
Guess	.04	*.01*	.05	*.02*	.03	*.01*	.03	*.01*	.03	*.01*	.04	*.01*
Tot.	.26	*.04*	.37	*.04*	.36	*.05*	.48	*.03*	.15	*.02*	.14	*.03*

As predicted, Guess judgements produced in response to studied words did not statistically differ to guess judgements produced in conjunction with unstudied words [$t = -.221$, $p = .826$] and therefore these judgements are omitted from overall analyses. Analyses were performed on uncorrected recognition data and on corrected recognition (hits minus false alarms) data. Separate analyses were carried for each of these two sets of data. As for the first experiment, the analyses over the two sets of data yielded very similar patterns so only analyses on uncorrected data are reported. A two way mixed ANOVA was carried out with response signal delay as a between participant factor (500 vs. 1500 ms) and depth of processing as a between participant factor. Remember and Know was treated as a within factor to enable comparisons related to the speeded recognition procedure.

As with Experiment 1, there was a significant main effect of signal delay [$F_{(1,38)} = 240.05$, $p < .001$] with more recognition responses in the longer delay condition. The effect of generation was also significant [$F_{(1,38)} = 12.75$, $p = .001$] but this time, because of the longer retention interval, the amount of Remember, as compared to the amount of Know judgements, did not significantly differ [$F_{(1,38)} = .660$, $p = .422$]. The interaction between signal delay and the generate/read manipulation was not significant [$F_{(1,38)} = .013$, $p = .909$] replicating Toth (1996) again in relation to the presence of a significant conceptual manipulation at both the long signal delay (which was expected) and at the short signal delay which would suggest conceptual effects on familiarity based responses. Though, the interaction between delay and response type was not significant [$F_{(1,38)} = .177$, $p = .677$]. This finding suggests, contrary to Toth's (1996) earlier claim, that the signal delay procedure curtailed recognition performance of both familiarity and recollection in equal measures, at least as indexed by Remember and Know judgements. This effect can be readily seen in the graph of fig. 2.2. Furthermore, as in Experiment 1 the interaction between the generate/read variable and response type was significant. Further analyses qualified this interaction as resulting from a generate/read effect on recognised items that were accompanied by a Remember response [$F_{(1,38)} = 15.24$, $p < .001$]. However, no generate/read effect was found in the recognised items that were accompanied by Know responses [$F_{(1,38)} = .27$, $p = .609$]. The three way interaction was not significant [$F_{(1,30)} = .296$, $p = .590$].

FIGURE 2.2.
EXPERIMENT 2: REMEMBER, KNOW AND GUESS RESPONSES AS A FUNCTION OF STUDY TASK AND RESPONSE DEADLINE



As in Experiment 1, contrary to what was previously assumed by dual process theorists, the shorter deadline did not seem to have the effect of successfully capturing familiarity based responses as indexed by Know judgements. Furthermore, it was found that the effect of the conceptual manipulation seemed mainly located on recollection based recognition responses as measured by Remember judgements not in Know judgements at both the longer and shorter recognition delays.

Familiarity and recollection estimates from the Independence Remember/Know model (e.g., Jacoby, Yonelinas, & Jennings, 1997) were computed for this experiment as well. The mean proportions of these estimates are reported in Table 2.4. An inspection of the table shows that familiarity, which should remain constant, increases with delay. Also, there is little evidence of a depth-of-processing effect on the familiarity estimate. Paired comparisons between the familiarity estimate for the read condition and the familiarity estimate of the generate condition show a non significant difference at the short delay ($t = -.85$, $p = .40$) and at the long delay ($t = -.97$, $p = .40$). Depth-of-processing effects on the familiarity estimates were not found, contrary to the results Toth (1996) obtained with the PDP.

TABLE 2.4

RECOLLECTION AND FAMILIARITY ESTIMATES FROM THE IRK MODEL, AS A FUNCTION OF STUDY TASK AND RESPONSE DEADLINE.

IRK estimates	***Read***		***Generate***	
Recollection	.08	.13	.19	.23
Familiarity	.16	.23	.19	.28

2.8 General Discussion

In both experiments, recognition performance was significantly reduced when responses constrained by a short deadline are compared to responses constrained by a longer deadline. According to dual process theories of recognition (Juola et al., 1971; Jacoby, 1983; Jacoby & Dallas, 1981; Mandler, 1980) which postulate a faster familiarity component and a slower recollective component, the recognition responses curtailed at the short delays should mainly be recollection based responses. By combining the speeded recognition procedure with reports of state of awareness associated with recognition responses, more accurate inferences could be drawn on the time-related operations of recollection and familiarity. In the two experiments, it was found that following a shorter deadline (or at least with the deadline of 500 ms imposed by Toth) there is little evidence that mainly recognition performance mediated by recollection is curtailed. In fact, the short deadline seems to truncate in similar fashion both recollection and familiarity based responses as indexed by Remember and Know responses.

In Toth's (1996) study, it was concluded that the presence of a depth-of-processing effect on recognition performance at the short deadline, which was believed to capture mainly familiarity responses, signalled the presence of conceptual effects on the component of familiarity. In the two experiments, Toth's (1996) finding of a depth-of-processing effect at the shorter deadline was replicated. However, by adding state of awareness reports to the speeded recognition procedure, it was possible to further clarify which recognition state showed the conceptual effects. In both experiments conceptual manipulations effects of depth of processing and of generate/read were found only for the responses based on recollection, as measured by Remember judgements. Know judgements were unaffected by either conceptual manipulations. This is consistent with previous findings with the Remember/Know procedure where similar patterns have consistently been obtained (Gardiner, 1988; Rajaram, 1996; Gardiner et al., 1996).

As the Know judgements at the shorter delay are rather small in number, it can be argued that there is not enough power for an effect of conceptual manipulation to be revealed. To test the hypothesis, a median split analysis of Know judgements at the shorter delay, combined for both experiments, was carried out. The data from the 8 participants in Experiment 1 and 10 participants in Experiment 2 who reported a number of Know judgements at the short deadline above the median were re-analysed. The average Know-judgements proportion from the 18 participants for items studied with the semantic orienting task or with a generation task was .19. For the items studied with a phonemic orienting task, or when just read in Experiment 2, the average Know-judgements proportion was .18. This difference was not statistically significant. So even the participants who reported a larger than average number of Know judgements at the short delay, failed to show an effect of meaning-based study processes.

Floor effects could also be responsible for a lack of the conceptual manipulation effects on the estimate of familiarity obtained with the IRK procedure The same median split analysis was carried out on estimates of familiarity. This time, the data from the 8 participants in Experiment 1 and 10 participants in Experiment 2 who reported a familiarity estimate at the short deadline above the mean were re-analysed. The average familiarity-estimates proportion from the 18 participants for items studied with the semantic orienting task or with a generation task was .23. Following the phonemic or read orienting task the mean familiarity-estimate proportion was .22. From these results it is concluded that floor effects were not responsible for a lack of conceptual elaboration effects on familiarity estimates derived with the IRK procedure.

In Toth's (1996) experiment, the number of recollection based recognition responses which, it can now be argued, were preserved at the shorter delay, was probably sufficient to show a conceptual manipulation effect. This result would undermine the inference of the presence of conceptual effects on the familiarity component. In these current experiments however, the states of awareness were not reported at the moment of the recognition decision, they were only reported immediately after a positive recognition response. Although this is standard procedure in the use of Remember and Know judgements, it cannot be inferred that the full recollective or knowing experience is present at the moment of the time-constrained recognition decision. However, the current experiments show that recognition responses, that are produced within a short delay are responses that are then eventually associated with a particular state of awareness. The patterns of these states of awareness associated with time-constrained recognition responses and their relation to the effects of conceptual manipulations cannot be easily explained by traditional dual process theories of recognition.

One alternative would be that recognition at the short delay is mainly familiarity based, but once the participant is allowed to take time to recollect, then they will have a recollection experience for some items but not other. If this is the case, familiarity as indexed by Know responses is a very different phenomenon from the fast familiarity conceptualised within dual process theories.

Such familiarity can only be seen as an underlying, automatic property of both Remember and Know judgements in the first instance, but it does not predict whether the word will be recollected or simply known at a later stage. For example, we can say that items whose recognition is truncated by the shorter delay are not just items that are eventually mainly recollected. Items that give rise to a state of awareness associated with a feeling of familiarity are curtailed by the shorter deadline in similar measure to items associated with a conscious recollection of some aspect of the study episode. With the Remember/Know procedure, it was also demonstrated that effects of conceptual manipulation at study are to be found only for those items that are subsequently associated with a Remember judgement. This finding should be taken into account before inferring conceptual manipulation effects on familiarity.

The results of the two experiments do not necessarily imply that familiarity, as conceived within dual process theories, does not have the characteristic of fast acting as ascribed by the theories. However, the results imply that familiarity as indexed by Know judgements does not conform to the attribute of familiarity described within dual process theories. This form of familiarity does not conform to the defining characteristics of noetic consciousness. The familiarity of an item is postulated regardless of the phenomenological experiences associated with it. In fact, if the shorter deadline captures more automatic responses, we are to conclude from these results that remembering as well as knowing maybe triggered relatively automatically. These experiments provide further evidence for the existence of a more automatic form of recollection experience (Gardiner, Ramponi, & Richardson-Klavehn, 1998; Gooding, Mayes, vanEijk, Meudell, & MacDonald, 1999). Dewhurst and Conway (1994) also found that response latencies for recognition responses, which were subsequently related to Remember judgements, were shorter than those associated with Know judgements. The search and retrieval process associated with recollection, as postulated in dual process theories, does not take into account those sudden recollective experiences that a participant may associate to an item.

2.8.1 Concluding Remarks

In the two experiments, little evidence was found for effects of conceptual manipulation on Know judgements. On the basis of this finding, it can be argued that operations that mediate recognition responses accompanied by Know judgements have little in common with the operation which are mediated by conceptual priming. However, as reviewed in Chapter 1, meaning-based study processing effects on conceptual priming have not been constantly reported (Schacter & McGlynn, 1989; Vaidya et al., 1997). In the following chapters, a detailed investigation of the effects of conceptual manipulations of study processing on measures of conceptual priming are investigated further.

Chapter 3

Conceptual Processing and Word Association

Overview of Chapter 3

A review of the literature relating to conceptual priming revealed a small but increasing number of studies that provide some evidence for the dissociation between performances on intentional and incidental conceptual tests of memory. However, both tests seem affected by manipulations of conceptual processing at study and, on this basis, the dissociation of performance on the two tests has been questioned. In this study it is aimed to elucidate further the nature of effects of meaning-based study processing on conceptual priming in order to understand its relationship to voluntary and perceptual priming. In the following experiment, voluntary and conceptual priming is analysed as a function of four levels of study processing. There are at least two studies in the literature that failed to obtain depth-of-processing effects on a conceptual incidental test, and these studies both involve the word association task (Schacter & McGlynn, 1989; Vaidya et al., 1997). From the two studies there is a suggestion that, in the case of the presence of a stable representation, like the association between two strongly related words, depth-of-processing effects in incidental tests are negligible. In the following experiment, the association strength between words was varied systematically. This enabled a finer grain analysis of the interaction of the type of representation, whether stable or less stable (as indexed by association strength), with depth of study processing effects in conceptual priming. The main finding was that strongly related words are not susceptible to a depth-of-processing effect in the incidental test. Instead this is not the case when they are retrieved in the intentional test. A depth-of-processing effect was however found in the incidental test for word-pairs with a weaker association. The results show a dissociation only for the strongly related pairs between pairs retrieved in the incidental test and pairs retrieved in the intentional test. This kind of result goes some way to explain discrepancies found in the literature when meaning-based study processing effects in incidental tests are reported.

3.1 Introduction

As reported in Chapter 1, within the systems approach to the study of memory, the dissociations between intentional and incidental tests are explained by the existence of separate memory systems that mediate performance in the two types of tests. Instead, within the processing orientation, the dissociations between performances in the incidental and intentional tests are explained as the result of the selective engagement of different forms of processes according to the demands of the test. Process theorists argue that the task demands of (perceptual) incidental tests typically call upon data-driven processes. Instead, the task demands of intentional tests typically call upon conceptually driven processes.

Tests have been devised which require voluntary retrieval but also demand data-driven processes. Graphemic and phonemic cued-recall would be an example of such a test. The participant would engage in retrieval of studied words that are graphemically or phonemically similar to the cue word. Whether the participant engages in voluntary retrieval of studied items or not, is irrelevant, as the graphemic or phonemic cue initiate a data-driven process which can be affected by more *perceptual* variables. In addition, a task can be constructed that does not require voluntary retrieval but that, at the same time, engages more *conceptual* processes. In conceptual tasks, participants are asked to invoke their semantic knowledge to provide, for example, an associate in response to a cue word, or a category-exemplar in response to a category name, without voluntarily retrieving earlier studied words. Process theorists argue that the dissociations observed between incidental and intentional tests are explained by the different processing demands for either data-driven or conceptually driven processes, rather than the different nature of retrieval which participants engage in.

As reviewed in the introduction, the systems and the processing approach are not necessarily opposed because we can think of a set of processes as a small system, as advocated by the components-of-processing theory (e.g., Moscovitch, 1994). The positions are changing and merging to take into account the available evidence. Tests may share some processes in common, but other will differ on any two tests that can be dissociated. However, systems theorists still emphasise the voluntary/involuntary distinction and thus far they emphasise the importance of conscious correlates of memory and try to outline and understand their role in memory. Systems theorists tend to argue that the distinguishing characteristic of the system that sub-serves performance in intentional tests, is its role for the volitional and conscious retrieval of past episodes. The systems that sub-serve performance in incidental tests are distinguishable by their operation at the involuntary and, sometimes, non-conscious level.

The process theory argues that the critical distinction that can explain the different performance on incidental and intentional test is the distinction between perceptual and conceptual processes. Dimensions such as voluntary and involuntary retrieval, or conscious and unconscious correlates of retrieval, are dimensions that are not critical to the approach. Theories put forward within this perspective underplay the usefulness of the construct of involuntary memory to describe and characterise memory function.

Studies that have attempted to assess the merits of the two perspectives have focussed on conceptual priming, which combines conceptually driven processes with involuntary retrieval. The logic of these studies are as follows. If performance in conceptual incidental tests is found to dissociate from performance in intentional tests, then the voluntary/involuntary distinction is a useful explanatory construct. Instead, if the two tests are found not to dissociate because they both engage conceptually driven processes, the dissociation between intentional and incidental perceptual tests is explained as the result of the engagement of conceptually driven and data-driven processes respectively.

The picture on dissociations between conceptual incidental tests and intentional tests is confused. Some general conclusions may be drawn from the review of the literature in Chapter 1. In general, the effects of participant variables such as amnesia (e.g., Cermak et al., 1995), ageing (e.g., Monti et al., 1996), schizophrenia (Schwarz et al., 1993) and Alzheimer disease (e.g., Jelicic, 1996), seem to support the systems approach. According to the majority of the studies, these populations tend to show intact conceptual incidental tests and impaired performance in intentional tests. Functional dissociations in favour of the processing approach are rarely reported. Furthermore conceptual repetition (McDermott & Roediger, 1996), picture (e.g., Weldon & Coyote, 1996), enactment (Nyberg & Nilsson, 1995), and serial position (Brooks, 1999) effects have been found for intentional memory tests but not in conceptual incidental tests, attesting to a dissociation between the tests.

However, in general, depth of processing (e.g., Roediger & Srinivas, 1990), divided attention (e.g., Mulligan & Hartman, 1996). and generate/read (e.g., Blaxton, 1992, 1989) manipulations, all of which modulate meaning processing at study, have an effect on performance in conceptual incidental tests. This favours a processing distinction as the explanatory variable. A notable exception in functional dissociations of this kind is, though, found for the task of word association. At least two studies (Vaidya et al.,1997 and Schacter & McGlynn, 1989) have shown non-significant effects of study processing manipulations on conceptual priming. The suggestion from such studies is that the important variable to consider is the degree of association between word-pairs presented at study. When weakly associated words are used, priming is shown only following elaborative study processing. However, when word-pairs with a more stable association are used, priming is similar following elaborative or less elaborative study processing (Vaidya et al., 1997; Schacter & McGlynn, 1989).

3.2 Experiment 3

Challis et al. (1996) argue that to make any inference of involuntary memory, several aspects of the experimental situation must be considered. The type of information about the stimulus that the encoding task invokes, and therefore what is encoded, should be carefully analysed. The retrieval task, with its informational requirements and its compatibility with the encoding task, should be considered. In the following experiment, a detailed study of the word association task is carried out. Four types of study tasks are employed in order to enable a more precise analysis of the effects of study processing on conceptual memory tests. Participants studied words with a graphemic, phonemic, semantic and self-related orientation instructions. This range of study tasks should enable the identification of the depth of processing required for conceptual priming to be observed. The association strength of the word-pairs presented for study was also varied systematically. Following previous custom, the probability that any given associate is produced in a free association task, is taken as an index of its relative strength in relation to the cue word. It is assumed that words are connected to their associates in memory as the result of language experience. A continuous range of word association strengths was broken down in three subgroups of high, medium and low association strength. This enabled the detailed analysis of the interaction between depth of study processing and association strength. In the study, the type of relationship between word-pairs is also taken into account so that nominal compounds (e.g., *hand-lotion*) or category instance relations (e.g., *flower-daisy*) were rejected to prevent possible confounding factors. Furthermore, in the study, the second word in the pair is selected so that it is the most frequently produced association according to the word association norms (Moss & Older, 1996), regardless of association strength. This procedure differs from the practice of presenting the same cue word with a frequently produced associate compared with a less frequently produced associate. This procedure avoids the confounding factor of interference from more dominant associations for the weakly related pairs. Word-pairs were presented at study; whereas at test the first word was presented and participants attempted to produce an associated word. The intentional form of the task required participants to recall the associates from the study phase; the incidental form of the task required participants to generate the first word that came to mind in response to the cue word. In the incidental task participants were explicitly instructed not to *recall* associates from the study phase, to counter contamination from a change of strategy.

The systems and processing approach would make opposite predictions on the outcome of such experiment. From the systems perspective, where the critical distinction is between the intentional/incidental nature of the test, it is predicted that incidental test performance will not show a depth-of-processing effect when performance on voluntary retrieval will. From the processing perspective, where the role of conceptually and data-driven processes is critical, it is predicted that conceptual manipulations would modulate performance in both conceptual incidental and intentional tests. The two tasks would not dissociate as the intentional and incidental nature of the test is irrelevant.

3.3 Method

3.3.1 Participants, Design and Materials

The participants were forty-eight students from City University. They were either paid for their participation or participated for partial fulfilment of course credits. The experiment adopted a 2x4x3 mixed factorial design (see Appendix 3.1) with test instructions as the between-participants variable with 2 levels (incidental vs. intentional), depth of study processing as a within-participants variable with 4 levels (graphemic, phonemic, semantic, self-related) and association strength as a within-participants variable with 3 levels (high, medium and low). Participants were randomly assigned to the two tests conditions (incidental vs. intentional retrieval instructions) with 24 participants in each of the two groups. At study, each participant underwent the four depth of processing study conditions. These were blocked and rotated according to a 4x4 Latin square to fully counterbalance order.

The materials consisted of 216 word-pairs (see Appendix 3.2) selected from the Birkbeck Word Association Norms (Moss & Older, 1996) according to their association strengths (see Appendix 3.2). For all levels of association strength, only the most frequent associate of the cue word was selected for all the pairs. This was used to avoid any effects from stronger associates of the cue words. Word associations produced by 65% to 45% of participants in these norms, were selected as word-pairs with high association strength. The mean association strength of the high associates was 55%. Pairs with an association that yielded a baseline production between 45% to 25% were considered word-pairs with medium association strength. The mean association strength of the medium associates was 34%. Baseline production between 25% and 5% were considered word-pairs of low association strength. The mean association strength of these low associates was 15%. (These lists of word-pairs are reported in Appendix 3.2.) Words were selected if there was a semantic relation between the words. The words in the word-pairs tended to be synonyms or opposites. Category/instance relationships or a nominal compound relationship as well as uncommon or too abstract words were rejected. For each association strength 72 pairs were selected forming a total of 216 word-pairs.

The 216 word-pairs were divided systematically into six lists of 36 word-pairs each with very similar association strength on average. Of these 36 word-pairs, 12 were word-pairs with high association strength (e.g., *umbrella-rain*), 12 were pairs with medium association strength (e.g., *squirrel-nut*), and 12 were pairs with low association strength (e.g., *travel-plane*). Each list was constructed so that the mean association strength was similar at around 34%.

At study, the 36 word-pairs in each list were presented in a fixed random order for all participants. A separate list of 36 word-pairs was used for each of the four study conditions. At study, each participant saw in total 144 word-pairs. At test, 216 word-pairs were presented. These included all the four lists of 36 words-pairs presented at study plus two unstudied lists of 36 word-pairs each. In total there were 144 studied word-pairs and 72 unstudied word-pairs. The studied/unstudied status of the six lists was rotated according to a 6x6 Latin square, with 4 studied lists and 2 unstudied lists presented in 6 different orders. The 216 word-pairs presented at test were randomised in a unique order for each participant.

An Apple Macintosh PowerBook (1400c) computer programmed in the HyperCard environment was used to present all the stimuli and to collect participants' responses.

3.3.2 Procedure

Each participant was tested individually. Participants were naïve to the purpose of the experiment and were only told that they would carry out a set of verbal tasks.

Study phase

In the study phase participants were seated in front of a portable computer and were shown the instructions on the computer screen (see Appendix 3.3). Participants were told that they would carry out four simple operations in response to word-pairs that were going to be presented on the screen. Participants were instructed at the beginning, before any presentation of word-pairs, about the nature of the four operations they were to carry out. However, the instructions were presented in 4 different orders on the computer screen. This order of presentation corresponded to the order in which the participant was about to carry out the operation according to the counterbalancing of the study conditions. For the *graphemic* study condition participants were instructed to decide which one of the two words presented on the screen had more letters that extend above the main body of the word (e.g., b,f,t). In the *phonemic* study condition participants were instructed to decide which one of the two words had more syllables. In the *semantic* condition, they were instructed to decide which one of the two words had the more pleasant meaning. In the *self-related* condition, they were told to decide which one of the two words was more important to them now or in the future. Participants were told that a set of instructions at the top of the screen would remind them what operation they would have to carry out for each word-pair set. Participants were told that they would have to carry out the same operation for a series of 36 word-pairs and then the instructions would change prompting them to carry out the next operation on the list with other word-pairs.

Word-pairs were presented in the middle of the screen with the first word the cue word presented on the left side of the screen and the second word the target word presented on the right side of the screen. The two words were one inch apart. The words were presented in lower case and the font and size was Times 50 point. Word-pairs were presented on the screen for five seconds and the inter-stimuli interval was of one second.

Immediately below each word (directly in the middle of the word) there was a small empty circle on the screen. Participants were instructed to select one of the two words by pressing the mouse button when the mouse pointer was in the small circle beneath the selected word. In the case where the words were the same with respect to the operation they had to carry out (e.g., the words had the same number of syllables, or they were equally pleasant) participants were to press the mouse button when the pointer was in the third small empty circle, which appeared in the middle of the other two circles, with no word above it. Participants were instructed that they had to make their selection within the 5 seconds during which the word-pair appeared. If they were to miss one trial, they were to just concentrate on the next trial. Participants had no difficulty in making their selection within these time limits.

Distractor tasks

Participants had to carry out two distractor tasks between the study and the test phase for a total duration of approximately 10 minutes. In the first task, participants were presented with one letter of the alphabet and they were to think of a city beginning with that letter. This task was designed to familiarise participants with the set-up of the study task. Participants saw a letter on the top left hand side of the computer screen and they were to say the name of the city. As they reported the name, the experimenter pressed a button that would show a text-box. The experimenter entered the name of the city in the text-box using a separate keyboard connected to the portable computer. The participant would have to verify the name of the city and following positive confirmation, the experimenter presented a new letter on the computer screen. The task finished once the participant had seen all the letters of the alphabet. To encourage a speedier completion participants were advised to take no more than approximately 10 seconds to think of a city beginning with the letter and if after about 10 seconds they could not think of one, they could pass on to the next letter.

The second distractor task was designed to familiarise the participant with word association tasks. The purpose of this task was also to minimise the extent of contamination from voluntary retrieval in the incidental test. This time the participant was presented with a common first name and they were to think of a surname associated with that name. It was emphasised that participants were to report the first surname that came to mind when they saw the first name, in order to maximise the production of an automatic response. To encourage a speedier (more automatic) production of the associated surname, participants were told to take no longer than 10 seconds and possibly a much shorter time. The surname could be of a famous person, or any fictional character from a book, film or program, or someone the participant knew. The common first name was presented on the screen and when the participant reported verbally a surname, the experimenter pressed a button that brought up on the screen a text-box and the experimenter typed in the surname. If the surname was typed in correctly, the next first name was presented.

Test phase

At the end of the distractor task, the test phase began. Twenty-four participants were presented with intentional retrieval instructions and the other twenty-four were presented with incidental retrieval instructions (see Appendix 3.4). The assignment to the two test conditions was randomly determined. In order to minimise voluntary retrieval in the incidental test, the test phase was presented as another word association task, similar to the two *city* and *name* distractor tasks previously carried out. To emphasise this continuation, the presentation format of the test phase was identical to the two distractor tasks. Participants assigned to the incidental condition were told that they would see a series of words presented one at a time. As they saw the cue word, participants were to say aloud the first word that came to mind that was associated to the cue-word. The associated word was not to be a proper name, but any other word that came to mind first was accepted. They were told that the experimenter was interested in the first word that came to mind immediately, not after thinking about it for a while. To ensure against voluntary retrieval upon realising the match of some of the words with those presented at study, following the procedure developed by Richardson-Klavehn and Gardiner (1995,1996), participants were explicitly told that they may find that some of the words were the same words saw earlier in the previous, separate, task and sometimes they may find that the first words that spring to mind were also words they saw before. Participants were told that this was because of an overlap in the material used for the separate tasks. They were strongly encouraged to disregard what happened before and always say the word that came to mind "first", whether they saw the word earlier or not. It was emphasised that the purpose of the task was not for them to come up with words from before.

Participants that underwent the intentional test condition had a different set of instructions (See appendix 3.4). They were told that in this task they would see a series of words presented to them one at a time. Most of the words they were going to see were going to be the same words as those they saw in the study task. The words they would see would be the words presented on the left-hand side of the screen in the study task. Their task was to use the word on the screen as a cue to remember the associated word that they saw appearing on the right-hand side of the screen at the same time in the study task. Given that one third of the words did not correspond to the studied words, they were told that they should not expect to be able to remember the associated word of all the words they were to see, as some of the cue words did not correspond to the previous ones. They were instructed that, if they recalled the associated word and they were positive that they saw the two words together, then they were to say aloud the associated word. If they found that they could not remember seeing the word before or they could not recall the associated word, they were to pass.

Under both conditions, the first word in the pair -the cue word- was presented on the top left hand side of the screen. When participants produced the spoken response, the experimenter pressed a button which brought up a text-box in the middle of the screen. The time lapse between the presentation of the cue word and the experimenter pressing the button immediately after the participant answered, was recorded. The experimenter then typed in the participant's response. Once the participant confirmed their answer, the experimenter presented the next cue word on the computer screen. Participants saw 216 cue words presented in a unique random order for each participant. All participants were debriefed and excused.

3.4 Results

A response was considered a target response only if the studied word and the word produced at test were lexically identical. Both plural and singular versions of studied words were deemed as target associations. Baseline association strength was calculated by the production of the selected word-pairs without the participant having studied the word-pair. The mean proportions of target associations are reported in Table 3.1. Each participant's score is reported in Appendix 3.5. The score for each item (used for the item analysis) is reported in Appendix 3.6. The means reported in the table below are from the participants' scores; the item analysis means are identical apart from some minor differences due to rounding.

TABLE 3.1

MEAN PROPORTIONS AND STANDARD ERRORS OF WORD ASSOCIATES THAT CORRESPONDED TO TARGET WORDS (STUDIED AND UNSTUDIED) AS A FUNCTION OF TEST INSTRUCTIONS, DEPTH OF PROCESSING AND ASSOCIATION STRENGTH.

	Studied								*Unstudied*	
Association	*Graphemic*		*Phonemic*		*Semantic*		*Self-related*		*(baseline)*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
					Incidental Test					
High	.59	.04	.68	.04	.72	.04	.69	.04	.56	.03
Medium	.41	.04	.49	.03	.59	.05	.61	.04	.40	.03
Low	.19	.03	.29	.03	.45	.04	.41	.05	.17	.01
					Intentional Test					
High	.11	.03	.21	.04	.75	.05	.66	.04	.01	.00
Medium	.10	.02	.22	.04	.76	.04	.70	.04	.01	.00
Low	.07	.02	.15	.03	.62	.05	.67	.04	.00	.00

The level of significance for all the following analyses was set at 0.05. A first analysis was carried out to verify the effect of test instructions on overall retrieval. A 2x4x3 mixed ANOVA with retrieval test (intentional vs. incidental) as the between variable and depth of processing (graphemic, phonemic, semantic, and self related) and association strength (high, medium, and low) as within variables, showed that the retrieval tests manipulation produced significantly different performances ($F_{(1,46)} = 5.33$, $p = .026$). There was also an overall significant effect of association ($F_{(1,46)} = 200.30$, $p<.001$) and of depth of processing ($F_{(1,46)} = 416.83$, $p<.001$). However, depth of processing had a different effect on performances in the two retrieval tests as qualified by the significant depth of processing by retrieval test interaction ($F_{(1,46)} = 141.70$, $p<.001$). Association strength also interacted with retrieval test ($F_{(1,46)} = 101.03$, $p<.001$) showing that association strength had a different effect on retrieval in the two tests.

A second analysis was carried out to check if significant conceptual priming was obtained in all conditions in the incidental test. By comparing target production of unstudied items with studied items for each of the four depth of processing tasks, significant conceptual priming effect was obtained following the *self-related* orienting study task [$F_{(1,23)} = 37.78$, $p<. 001$], the *semantic* study task [$F_{(1,23)} = 51.24$, $p<. 001$] and the *phonemic* study task [$F_{(1,23)} = 33.56$, $p<. 001$]. However, the *graphemic* study task did not yield significant conceptual priming [$F_{(1,23)} = .62$, $p>.05$]; therefore, the graphemic data from both the intentional and incidental test will not be considered in subsequent analysis.

The magnitude of conceptual priming was computed as the difference between the proportion of target associations for studied versus unstudied word-pairs. The mean priming magnitudes are reported in Table 3.2.

TABLE 3.2

MEAN PROPORTIONS AND STANDARD ERROR OF CONCEPTUAL PRIMING (UNSTUDIED BASELINE SUBTRACTED) AS A FUNCTION OF DEPTH OF PROCESSING AND ASSOCIATION STRENGTH.

	Studied							
Association	*Graphemic*		*Phonemic*		*Semantic*		*Self-related*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
				Incidental Test				
High	.03	.04	.11	.04	.15	.04	.12	.04
Medium	.01	.04	.08	.03	.19	.05	.20	.04
Low	.02	.03	.12	.03	.23	.04	.24	.05

As can be seen from Figure 3.1 (intentional test) and Figure 3.2 (incidental test), *self-related* study processing seemed not to produce an advantage over *semantic* study processing in the incidental and intentional tests. This observation was supported by statistical tests. In the intentional test, a 2x3 repeated measures ANOVA with depth of processing (self-related vs. semantic) and association strength (high, medium and low) as within variables did not reveal a significant effect of depth of processing ($F_{(1,23)} = 1.15$, $p=.294$). The interaction of depth of processing with association strength was significant ($F_{(1,23)} = 6.75$, $p=.018$) indicating that a depth of processing effect was not significant for the weakly ($t_{(23)} = -1.22$, $p=.235$) and medium ($t_{(23)} = 1.26$, $p=.222$) related words, but was significant for the highly related words ($t_{(23)} = 2.33$, $p=.029$). Nevertheless, for the highly related words the *self-related* processing manipulation at study actually conferred a slight disadvantage (see Figure. 3.1). Ceiling effects may be responsible for this finding for the strongly associated words, this issue is addressed in the next experiment in Chapter 4. In the incidental test, the same analysis did not yield a significant effect of depth of processing ($F_{(1,23)} = .036$, $p=.852$) for all levels of associations as there was no significant depth of processing by association strength interaction ($F_{(1,23)} = .67$, $p=.422$). Because of the overall lack of effect of the *self-related* study task over the *semantic* task, in subsequent analysis the data from the *semantic* and *self-related* condition are combined together to increase the power of the tests.

FIGURE 3.1
EXPERIMENT 3. INTENTIONAL TEST PERFORMANCE AS A FUNCTION OF WORD ASSOCIATION STRENGTH AND DEPTH OF PROCESSING

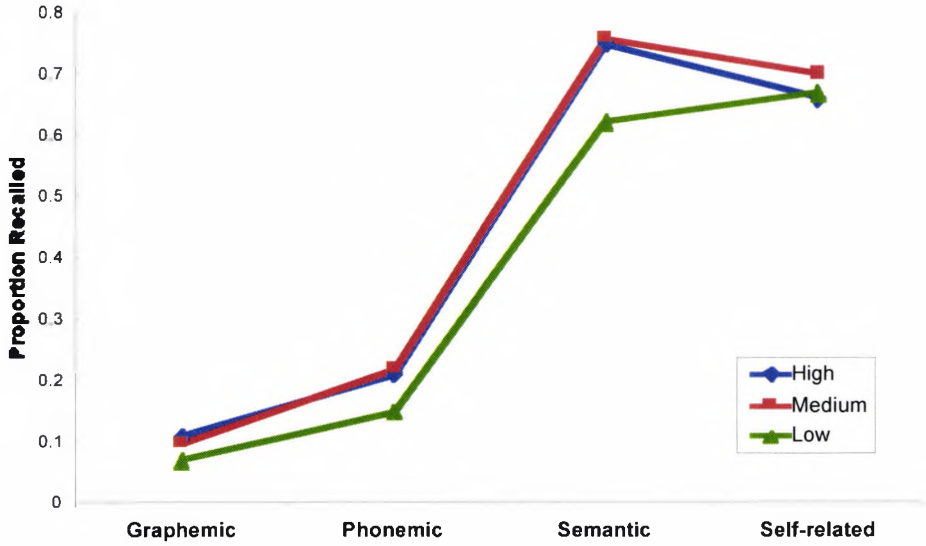
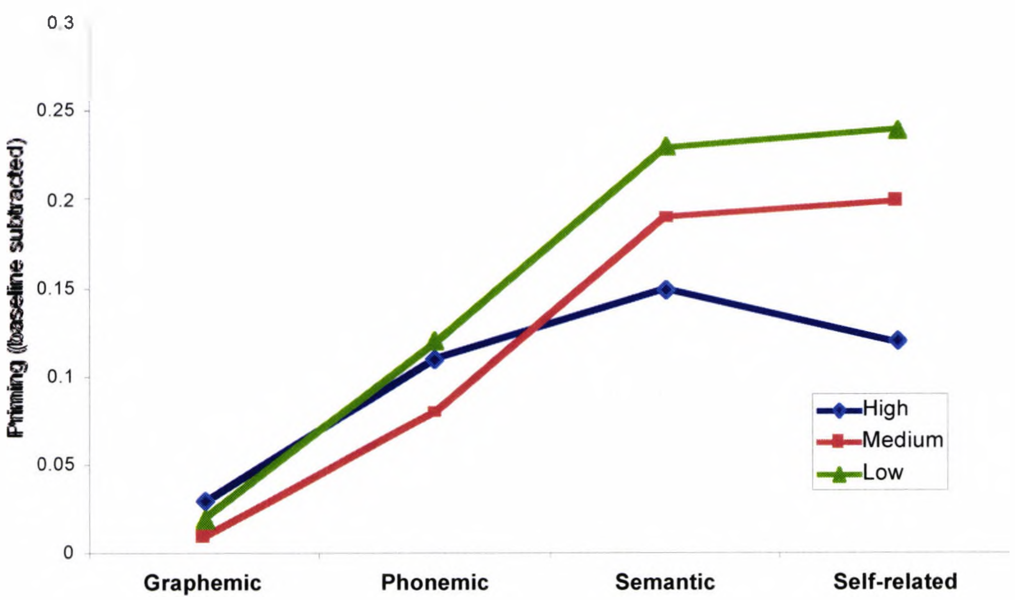


FIGURE 3.2
EXPERIMENT 3. INCIDENTAL TEST PERFORMANCE (BASELINE SUBTRACTED) AS A FUNCTION OF WORD ASSOCIATION STRENGTH AND DEPTH OF PROCESSING



All the following analyses were carried out on retrieval magnitudes corrected for retrieval of unstudied word-pairs to account for baseline differences; baseline performance was in fact different for levels of association (see Table 3.1). At the level of participants, unstudied baseline was subtracted from each incidental and intentional recall score in order to enable more appropriate comparisons unaffected by baseline performance. Separate analyses were carried out for the intentional and incidental test.

For the intentional test, a 2x3 repeated measures ANOVA with depth of processing (phonemic vs. semantic + self-related combined) and association strength (high, medium, and low) as a within variable was carried out. The analysis revealed a significant main effect of depth of processing at study ($F_{(1,23)} = 523.89$, $p<.001$) and of association strength ($F_{(1,23)} = 5.50$, $p=.007$). The important interaction between depth-of-processing effects and association was not significant ($F_{(1,23)} = .13$, $p=.882$) indicating that the depth-of-processing effect had similar impact on the three levels of associations. To be noted about this type of test instructions is also that, as can be clearly seen from Figure 3.1, no difference was found between recall performance for high associates and medium associates. A 2x2 repeated measures ANOVA with depth of processing (phonemic vs. semantic+self-related conditions combined) and association strength (high, medium) as within variables, yield a not significant main effect of association strength ($F_{(1,23)} = .282$, $p=.600$). Instead in the same type of analysis, comparing word-pairs of medium and low association strength a significant effect of association was reported ($F_{(1,23)} = 17.88$, $p<.001$).

For the incidental test, the same 2x3 repeated measures ANOVA, with depth of processing and association strength as within variables, was carried out on corrected data (conceptual priming). The analysis revealed a significant main effect of depth of processing at study ($F_{(1,23)} = 12.78$, $p=.002$) but not of association strength ($F_{(1,23)} = 1.75$, $p=.186$). This time though, the important interaction between depth of processing and association strength was significant ($F_{(1,23)} = 3.80$, $p=.030$) indicating that depth-of-processing effects had different impact on the three levels of associations. Planned comparisons revealed that there was a significant effect of depth of processing for the medium ($t_{(23)} = -.3.43$; $p=.002$) and low (t

$_{(23)}$ = -3.57; p=. 002) associates, but not for the high associates ($t_{(23)}$ = -.797; p=.433). Identical patterns were obtained in the same analyses with items for both the intentional and incidental tests.

In order to enable a finer grain analysis of the relationship between depth of processing effects and association strength, the current priming data was split into further association-strength categories. In Table 3.3 priming data was split into six levels of associations: The word-pairs in the high associates category, in which association strength range between 65% and 45%, were further split into two subcategories of very high association strength (*high a*: 65% to 55%), and of less high association strength, (*high b*: 55% to 45%). The same was done for the word-pairs in the medium and low category. An inspection of the table reveals that priming for the most strongly associated words were firstly very low and secondly showed no depth-of-processing effects. Instead, depth-of-processing effects could be seen already at the immediately following subcategory. This finding may suggest that there are ceiling effects on the strongly associated words. Therefore, the lack of a depth-of-processing effect on this set of words may be due to ceiling effects rather than to the nature of the corresponding representation of strong associates. This problem is addressed in Experiment 4 and 5.

TABLE 3.3

MEAN PROPORTIONS OF CONCEPTUAL PRIMING (UNSTUDIED BASELINE SUBTRACTED) AS A FUNCTION OF DEPTH OF PROCESSING AND SIX LEVELS OF ASSOCIATION STRENGTH.

	Studied			
Association strength	*Graphemic*	*Phonemic*	*Semantic*	*Self-related*
High a: 65 to 55%	.01	.10	.12	.04
High b: 55 to 45%	.05	.13	.19	.21
Medium a: 45 to 35%	-.02	.03	.12	.19
Medium b: 35 to 25%	.03	.12	.25	.22
Low a: 25 to 15%	.02	.17	.25	.28
Low b: 15 to 05%	.01	.08	.21	.21

3.5 Discussion

The aim of the experiment was to examine, to a greater extent than in previous experiments, the effect of varying depth of encoding processes, and the interaction of this variable with association strength effects, on the word association task under both intentional and incidental test instructions

In the incidental task an overall depth-of-processing effect was found when comparing retrieval following phonemic encoding processing with retrieval following semantic encoding processing. An overall depth-of-processing effect in the conceptual incidental task of word association would support the processing view of involuntary memory. An overall depth-of-processing effect was obtained in both the incidental and intentional version of the word association task, with semantic and self-related encoding instructions giving rise to more priming than phonemic encoding. (A difference between self-related and semantic orienting instructions was not found. As the same null effect was reported following intentional retrieval instructions, we can conclude that the self-related manipulation was not strong enough to produce a difference.)

However, more importantly, in the incidental test a significant interaction was reported between association strength and depth-of-processing effects. The interaction meant that word-pairs with lower association strength (medium and low associates) showed an effect of meaning-based processing at study, whilst no such effect was found on strongly associated word-pairs. In the intentional test a depth-of-processing effect was found for the word-pairs with medium and low association strength, as well as for the strongly associated pairs. With strongly related words, a theoretically important dissociation is obtained between the intentional and incidental test.

One other main finding was that not all encoding tasks were sufficient to enable conceptual priming to be expressed. No conceptual priming was obtained following the graphemic processing task. This was the case for all levels of association strength as there was no priming by association interaction. This is potentially a very important finding. If a comparison is made only between involuntary retrieval following graphemic encoding processing and semantic encoding processing, a depth-of-processing effect is reported which is parallel to the effect for voluntary retrieval. In this set of circumstances of a parallel effect on the intentional and incidental test comparing only two such encoding tasks, one theoretical conclusion is in support of processing theorists arguing against the usefulness of the voluntary/involuntary distinction. The other theoretical conclusion, in this set of circumstances, is that the incidental test may be contaminated by a voluntary retrieval strategy.

However, neither of these theoretical conclusions is supported when retrieval following phonemic study processing is compared with retrieval following semantic study processing. As reported in Chapter 1, Richardson-Klavehn and Gardiner (1998) found a depth-of-processing effect in the incidental task of word-stem completion when graphemic processing was compared with phonemic and semantic processing. However, a depth-of-processing effect was not found when retrieval following phonemic and semantic processing was compared; but the effect was present in the intentional test, still attesting to a dissociation between the tests. Richardson-Klavehn and Gardiner (1998) argued that the graphemic encoding task does not promote extensive lexical processing. If lexical processing is curtailed on some proportion of the words, then priming cannot be fully expressed at test. This curtailment of lexical processing would result in a depth-of-processing effect in involuntary retrieval.

This argument can also be extended to the current results. In the experiment, an absence of conceptual priming is observed following graphemic encoding processing. However, if a comparison is carried out between conceptual priming following phonemic processing and priming following semantic processing, a depth of processing for the strongly associated words is not observed. This same comparison in the intentional test does instead yield a significant effect of semantic over phonemic study processing. Therefore, by comparing a larger number of encoding tests, a dissociation between intentional and incidental test is still obtained going against the processing theory predictions and against a contamination of the incidental test hypothesis (e.g., Richardson-Klavehn & Bjork, 1988; Reingold & Toth, 1996; Toth & Reingold, 1996; Toth, Reingold, & Jacoby, 1994). What was found for the incidental test following graphemic study processing simply suggests that for conceptual priming to be expressed, word codes need to be accessed at study at least at the phonemic level. The simple encoding of structural features of the words is not sufficient for encoding an associative relation that enables conceptual priming.

The important dissociation, within the incidental conceptual test for different association strengths, begins to provide some explanation for the disparity of results reviewed in the literature. The importance of the association strength variable has been overlooked in studies using the word association task. This resulted in some studies reporting depth-of-processing effects on conceptual priming (e.g., Schacter & Whitfield, 1986; Weldon & Coyote, 1996; Carlesimo, 1994) and a few not reporting such effect (Schacter & McGlynn, 1989; Vaidya et al., 1997; Brooks et al., in press). The design of the current study, where association strength was varied on a continuum, enables a more systematic identification of the type of stimuli that are not affected by manipulations of elaborative processing at encoding. The current findings suggest that association strength is an important variable that has an impact on depth-of-processing effects on conceptual priming.

The dissociation that was obtained for strongly related words between the intentional and incidental tests, following a depth of processing manipulation, needs further explanation from process theorists. Process theorists argue that performance on the conceptual intentional and incidental test should not dissociate, as the two functions reflect the operations of common conceptually-driven processes; the involuntary/voluntary nature of the retrieval test being irrelevant. The findings point towards the possibility of different processes involved in the incidental and intentional test favouring a systems argument.

Findings of this kind though also beg an explanation from the systems approach to account for the dissociation within the incidental task between the retrieval of word-pairs of high and low association strength. A finer level of analysis of memory function is required to explain dissociations within tasks.

An insight into the causes of this kind of result can be found in some of the findings from the series of studies conducted by Graf and Schacter (1985, 1987, 1989; Schacter & Graf 1986, 1986, 1989) reviewed in Chapter 1. These studies analysed the learning of new associations measured though by the cued stem-completion task. As reported in Chapter 1, this paradigm requires participants to study unrelated word-pairs (e.g., *window-reason*). At test, a stem-completion task is proposed in which the word-stem is presented together with, either the paired word from the study phase (*e.g., window-rea?*), or with some other unrelated word (e.g., *table-rea?*). When the studied pair is reproposed at test, more target completions are made than when the *new* pairing is proposed, only following elaborative study processing (Graf & Schacter 1985; Schacter & Graf, 1986). Instead, priming effects in the stem completion task, when familiar words are used, are generally not sensitive to conceptual manipulations (Bowers & Schacter 1990; Graf & Mandler, 1984; Jacoby & Dallas, 1981). It was also found (see Chapter 1: Amnesia) that priming for new associations in stem completion is impaired in amnesic patients (e.g., Cermak, Bleich, & Blackford, 1988; Schacter & Graf, 1986b; Shimamura & Squire, 1989). And, some evidence indicates, associative priming is observed only in test-aware participants (Bowers & Schacter, 1993), but conditions seem to exist that show that associative priming can occur in non-test-aware participants (Howard, Fry, & Brune, 1991).

The findings that word stem completion priming for new associations requires elaborative processing at study, is impaired in amnesia, and is observed only in test aware participants, led Bowers and Schacter (1993) to suggest that stem completion in this task engages processes in common with voluntary retrieval. As mentioned in Chapter 1, Schacter (1994) and Bowers and Schacter (1993) proposed that the initial acquisition of a non-familiar association may be mediated by an episodic system which responds to elaborative processing and is possibly damaged in amnesia. The acquisition of novel semantic associations may depend to a large extent on hippocampal and other limbic structures that are typically impaired in amnesia.

However, it is unclear why voluntary processes would be selectively recruited in conceptual incidental tasks (Fleischman & Gabrieli, 1998) and in some ways, we can argue that there is no need to invoke the operations of an intentional system to explain parallel depth-of-processing effects. A more parsimonious explanation involves simply reasoning about representations. The studies on the acquisition of novel associations suggest that the degree of elaborative processing at study can simply determine whether an association between words can be strengthened and retained. An already established association, or a word, have a pre-existing representation; instead, a new association between semantically less related words, or non-words do not have a pre-existing representation. Once the word association is established and a compound or unitised (Schacter & McGlynn, 1989) representation is created, only then, it can be argued, can the representation be voluntarily or involuntarily retrieved. It follows that in conceptual incidental tasks where unfamiliar word-pairs are used, more elaborative encoding processing is necessary to establish an association between two words. As a consequence, the learning of this association is revealed in involuntary retrieval. However, in the case of the presentation of word-pairs with a more established representation, no learning is necessary and conceptual priming is not modulated by the type of study processing.

This line of reasoning implies that depth-of-processing effects in voluntary and involuntary retrieval would have different causes. As Bower (1996) proposes, what modulates retrieval in intentional tests is the extent of the binding of a study event with its temporal and spatial context, as well as the extent of the binding between the two words in the pair. Deeper level of processing can be seen as promoting the binding of the two words in the pair, as well as promoting the binding of a study event with its temporal and spatial context. Therefore, depth-of-processing effects expressed in intentional tests are the consequence of the extent to which encoding processing promotes binding of the two words together as well as the consequence of the extent to which encoding processing promotes the binding of the study event with its spatial and temporal context. Instead, what modulates retrieval in incidental tests is only the extent of the binding of the two words in the pair together. Therefore, depth-of-processing effects expressed in the incidental test are a consequence of the extent to which encoding processes promote the binding of the two words in the pair together. Therefore, when established associations are used, a depth-of-processing effect should occur in the intentional test of word association where a connection between the word-pair and the spatial and temporal context needs to be established. Instead, when established associations are used in incidental tests, depth-of-processing effects should not occur as the connection of relevance between the two words is already established. Instead, with unfamiliar associations where a representation needs to be established, a depth-of-processing effect should occur in both an intentional and incidental test.

This interpretation of the results can be integrated, to a certain extent, with a components-of-processing perspective, as it is advanced that conceptual priming and voluntary memory share a similar process of an automatic retrieval of information, which though in intentional tests is guided by the retrieval of information regarding the temporal-spatial context of the acquired information.

The interpretation of the results developed here also coincides well with the theory of involuntary memory proposed by Nelson et al. (1998) that different retrieval tests engage different types of representation formed at study. As reviewed in Chapter 1, Nelson et al. (1998) argue that priming engages an *implicit representation* and voluntary retrieval engages an *explicit representation*. The two representations are independent and retrieval instruction can bias the recovery of the particular representation. The *implicit representation* is created when the presentation of a word at study activates its lexical representation and related associates. Instead, the *explicit representation* includes contextual information and connections to other words in the list and its strength is modulated by the type of study processing. In voluntary retrieval, both types of representation contribute to memory performance. Instead, implicit representations are activated regardless of retrieval instructions as they are cued automatically.

The explanation developed in this chapter instead coincides less well with the proposal of Vaidya et al. (1997) that attempts to explain conceptual priming phenomena in relation to association strength effects. Vaidya et al. (1997) proposed a model that makes a distinction between competitive and non-competitive access to semantic knowledge. Non-competitive memorial access takes place when the retrieval cue in the incidental test of word association leads directly to the retrieval of the associated primed target. With non-competitive access, full priming is observed regardless of the type of processing employed at encoding. This would be the case for strongly related pairs where the cue word leads directly to the retrieval of the target word due to its strong connection. Conceptual elaboration does not add more to the priming of strong associates. In contrast, competitive memorial access occurs when the retrieval cue word in the word association test cannot lead directly to the associated primed target. This type of cue promotes a competition between various associated alternatives and this would be the case for weakly related primed targets. Following shallow study processing of weakly related pairs, alternative entries may win the competition at test, but in the case of deep processing, the target completion would probably win and hence priming is enhanced. In this way, Vaidya et al. (1997) argue that two different conceptual processes mediate conceptual priming. The processes may be dissociable on the basis of the presence or absence of competition among response alternatives initiated by the retrieval cue.

However, from the perspective developed in this chapter, it does not seem economical to advocate the existence of two different processes to explain the dissociation rather than just postulating that it is the same conceptual priming process which needs the presence of an established representation to be expressed. A representation needs to be in place for priming to be expressed above baseline performance and this is not the case for voluntary retrieval where other factors (i.e. the establishment of an association between a study event with its temporal and spatial context) determine recall performance.

One last point should be made about the current data. There is a possibility that a depth-of-processing effect could not be found for the highly related words because of ceiling effects related to the high association strength baseline. Ceiling effects in word association priming are difficult to assess: It is difficult to determine what are ceiling levels when a high baseline is involved. These issues are addressed in Experiments 3 and 4 in the following chapters.

Chapter 4

Conceptual Priming and Ageing

Overview of Chapter 4

The study reported in this chapter examines further the dissociations between conceptual intentional and incidental tests of memory in a population of older adults. In general, most studies report that older adults show marked voluntary memory deficits. There are also some studies that report evidence of impaired conceptual priming in older adults (Jelicic et al., 1996; Grober et al., 1992; Jelicic, 1995; Rybash, 1996). The parallel effect of ageing on voluntary retrieval and priming has been used as evidence by process theorists in support of the unitary memory argument. They argue that the two forms of retrieval are mediated by the *same* processes whose efficiency worsens in old age. However, there are other studies that have shown that older adults perform equally well as younger adults in conceptual incidental tests, in the presence of a difference in voluntary retrieval (Isingrini et al., 1995; Java, 1996; Light & Albertson, 1989; Monti et al., 1996). The current study aims to examine the possibility that the discrepant results between the studies are related to the type of representation created at encoding. Drawing from the results of the previous study, a prediction can be made that conceptual priming for already established representations, such as the associations between two strongly related words, will be equal in younger and older adults. Instead, an effect of age will be shown on priming that requires elaborative processing to be expressed (i.e., with less familiar associations). This would be because older adults have more difficulties in establishing the representations of less familiar associations and of its spatial/temporal context. In the study, strongly and weakly related words were studied with four orienting tasks that modulated depth of processing. For weakly related words, a depth-of-processing effect was found in both voluntary and involuntary retrieval. By contrast, strongly related words in the incidental test did not show an effect of meaning-based processing, replicating the earlier study (Experiment 3). Older adults showed significantly less memory overall in the intentional test, and only for the weakly related words in the incidental test.

4.1 Introduction

Normal ageing is associated with a decline in intentionally remembering past events. When compared to younger adults' performance in voluntary retrieval tasks, performance of older adults shows a fairly well documented decline (see Light, 1991). By contrast, initial studies that investigated involuntary memory, showed that older adults' performance in incidental tests, in general, was comparable to that of the younger adults (e.g., Light, Singh, & Capps, 1986; Dick, Kean, & Sands, 1986; Light & Albertson, 1989). This finding constituted a major exception to the generalisation that memory was affected by the process of ageing. Theories of cognitive ageing, which could explain effects of age on memory, had to be modified to take into account the new findings on priming.

The systems view of involuntary memory finds support from studies that show that older adults display intact priming and impaired voluntary retrieval. This kind of result would mirror the finding in amnesia and would support the conclusion that the episodic memory system can be selectively impaired by the process of ageing or in amnesic patients. Instead, the memory system which supports priming is spared by ageing and in amnesia. On the other hand, the processing view stresses that older adults would be impaired in their conceptual processes, whilst their perceptual processes are left intact by normal ageing. It is in this respect that findings on the effect of ageing on conceptual priming were considered crucial, as opposite predictions from the two camps arose. The system theorists argued for intact conceptual priming along with intact perceptual priming, attesting to the importance of the involuntary/voluntary dichotomy. Instead, the processing approach argued for reduced conceptual priming and voluntary retrieval in older adults in comparison to younger control, reflecting impaired conceptual processes.

The picture that has emerged from the literature on involuntary memory does not allow us to decide between the two proposals. In a meta-analysis, which included 39 conditions where priming was observed in older adults, La Voie and Light (1994) came to the conclusion that perceptual priming is also affected by normal ageing. And, a number of recent studies have now reported reduced priming in ageing (e.g., Chiarello & Hoyer, 1988). Fleischman and Gabrieli (1998) in a comprehensive review of priming in normal ageing also concluded that the earlier claims that ageing had no effect on performance in incidental tests of memory could no longer be sustained.

Nevertheless, Fleischman and Gabrieli (1998) report that 85% of studies reviewed showed a null effect of ageing. They suggest that some of the findings of impaired priming in older adults may be attributed to the inadvertent inclusion of participants with pre-clinical Alzheimer's disease. They suggest that it is possible that the mild impairment reported in meta-analysis of priming in ageing is due to a minority of individuals who are in an early stage of an undiagnosed Alzheimer's disease rather than the impairment being caused by ageing.

Considerably fewer studies were carried out on conceptual priming, but as reviewed in Chapter 1, these few studies also reported contradictory findings. Rybash (1996) in a review of studies of involuntary memory concludes that perceptual priming is left intact whilst conceptual priming (particularly priming requiring the formation of new associations) is impaired by ageing. Two studies were reviewed in the introduction (Jelicic et al.,1996; Grober et al., 1992) that reported effects of ageing in a conceptual incidental tests. Furthermore, Ergis et al. (1998) found that older adults showed no priming for new associations while younger adults did.

However, Fleischman and Gabrieli (1998) in their review argue that the evidence points in the opposite direction, where conceptual priming is not affected by ageing. Four studies were reviewed in the introduction (Light & Albertson, 1989; Isingrini et al., 1995; Java, 1996; Monti et al., 1996) that have found that younger and older adults showed similar levels of priming in conceptual incidental tests. Furthermore, experiments carried out by Howard et al. (1991) on the priming of new associations reported some evidence of a lack of an age effect in this task too.

4.2 Experiment 4

In this experiment, older adults' involuntary and voluntary retrieval of strongly and weakly related word-pairs is compared with retrieval in younger controls. According to the systems approach, older adults should show an impairment of memory in intentional tests and no impairment in conceptual incidental tests. Instead, according to the processing approach, older adults should be impaired in both the intentional and incidental versions of conceptually driven tests.

In the previous chapter, it was found that priming for strongly related words is not affected by the depth-of-processing manipulation. It was suggested that the representation of the association between strongly associated words is already in place, therefore, elaborative processing will not confer any advantage. Instead, weakly associated words require deeper study processing for the representation of an association to be established in the first place, to enable the association to be involuntarily retrieved.

There are three possible outcomes for the incidental test results of the next experiment. Older adults' performance could be intact for both strongly and weakly related associates, supporting the system's emphasis on the voluntary/involuntary distinction as important to characterise older adults' memory function. Alternatively, older adults' performance could be impaired for both strongly or weakly associated words, supporting the processing emphasis on the importance of the conceptual/perceptual dichotomy. The third possibility is that older adults could show a deficit in performance with weakly associated words, but not with strongly associated words. This would be expected if involuntary retrieval is deemed spared by the ageing process and an encoding deficit hypothesis is adopted as an explanation of older adults' memory performance (e.g., Perfect & Dasgupta, 1997; Perfect, Williams, & Anderton-Brown, 1995). Pre-existing associations between strongly related words do not require elaborative processing to be expressed, instead associations between weakly related words need to be learned. If older adults are impaired in their processing for establishing a representation of the unfamiliar association, a deficit in priming should be observed for weakly related words but not for the strongly related words.

In Experiment 3, where association strength was varied systematically, it was possible to better identify the relationship between levels of association strength and the depth-of-processing manipulation. In Experiment 4 the strongly associated words were selected with an average baseline of 60%. This association strength level was stronger than that adopted in the previous experiment as there was evidence that association strength between 45% and 55% was susceptible to depth-of-processing effects. The weakly related pairs for the current experiment were also selected to have very low association strength with average baseline of 12%.

In this experiment four levels of processing (graphemic, phonemic, semantic and image) were employed. The graphemic processing task was adopted in an attempt to replicate the earlier finding of no conceptual priming following this study task. The fourth encoding task adopted in Experiment 4 differs from Experiment 3. In the previous experiment the study task asked participants to relate the words in the pair to some event in their life. This task was expected to lead to higher cued-recall performance than the semantic orienting task, but it did not. In this experiment participants were asked to create an interactive image of the referent of the two words in the pair, as there is evidence that image processing leads to higher recall levels (Paivio, 1986).

In Experiment 3, retrieval magnitudes following semantic processing at study in the incidental test were very similar to retrieval magnitudes in the intentional test. This similarity is suggestive of a ceiling effect in the incidental retrieval test. This ceiling effect may be responsible for the lack of a depth-of-processing effect on incidental test performance when baseline association strength is very high. The ceiling effect would have the effect of reducing incidental test performance for the word-pairs studied with a conceptual study task. In the current experiment it was aimed to increase voluntary retrieval performance following the semantic and the image orientation task to maximise the chances of showing an effect of conceptual study processing for the strongly related words in the incidental test. The chances for higher retrieval magnitude in the intentional test were extended by decreasing the number of word-pairs at study and by increasing stimulus exposure time from five to six seconds. Increase in exposure time was in any case necessary to enable participants to carry out the creation of the interactive image task as in a pilot study participants reported difficulties in accomplishing this task with tight time constraints.

4.3 Method

4.3.1 Participants

Forty-eight older adults and forty-eight young students volunteers took part in the study. The older adults group had a mean age of 71.67 years (with a range of 63-84). The older adults were all attending courses at the University of Third Age, and were recruited via that institution. In the younger group, there were forty-eight students from City University and Westminster University who did not take part in the previous experiment. The students were either paid for their participation or participated for partial fulfilment of course credits. This group had a mean age of 23.81 years (with a range of 18 to 38). A shortened form of the Mill Hill Vocabulary test (Raven 1965, maximum score 20) was administered to all participants to assess verbal ability. The mean score for the older adults group was 17.22 and the mean score for the younger group is 13.17. Older adults significantly outperformed the younger participants ($t= 7.17$, $p<. 001$).

4.3.2 Design and Materials

In the experiment, a 2x2x4x2 mixed factorial design was adopted. Age group and test instructions were the two between-participants variables with two levels (young vs. old, and incidental vs. intentional). Depth of processing at study was the within-participants variable with four levels (graphemic, phonemic, semantic, image creation). Association strength was the other within-participants variable with two levels (high vs. low association strength). Participants in the young and older adults groups were randomly assigned to the two test conditions, with 24 participants in each condition. At study, each participant underwent the four depth-of-processing study conditions. These were blocked and were rotated according to a 4x4 Latin square to fully counterbalance order (see Appendix 4.1).

The materials consisted of 168 word-pairs selected from the Birkbeck Norms (Moss & Older, 1996) according to the association strength (see Appendix 4.2). As in Experiment 3, the most frequent associate of the cue word was always selected. This was used to avoid any effects from stronger associates of the cue words. Word-pairs produced by 70% to 55% of participants under baseline conditions in the Birkbeck norms were selected as word-pairs with "high" association strength (e.g., *captain-ship*). The average association strength of the high associates list was of 61%. Word associations that yielded a baseline production in the Birkbeck norms between 15% to 6% were considered word-pairs with "low" association strength (e.g., *crisis-drama*). The average association strength of the low associates list was 12%. Word-pairs were selected by using the same criteria as in Experiment 3. For each association strength, 84 word-pairs were selected, forming a total of 168 word-pairs.

The 168 word-pairs were divided systematically into six lists (see Appendix 4.2) of 28 word-pairs each. Of these 28 word-pairs, 14 were word-pairs with high association strength and the other 14 were pairs with low association strength. Each list was constructed so that the mean association strengths were almost identical at around 36 %.

The 28 word-pairs in each list were presented in a fixed random order for all participants . A separate list of 28 word-pairs was used for each of the four study conditions. At study, each participant saw in total 112 word-pairs. At test 168 word-pairs were presented. These included all the four lists of 28 words-pairs presented at study plus two unstudied lists of 28 pairs each. In total, two thirds (112) of the word-pairs were studied and the other third (56) were unstudied word-pairs. The studied/unstudied status of the six lists was rotated according to a 6x6 Latin square, with four study list and two unstudied lists presented in six different orders (see Appendix 4.1). The 216 cue words presented at test were randomised in a unique order for each participant.

An Apple Macintosh PowerBook (1400c) computer - programmed in the HyperCard environment - was used to present all the stimuli used in the experiment and to collect participants' responses.

4.3.3 Procedure

Each participant was tested individually. Participants were naïve to the purposes of the experiment and were only told that they would carry out a set of verbal tasks. In the study phase participants were seated in front of a portable computer and were shown the instructions on the computer screen. As in Experiment 3, participants were told that they would carry out four simple operations in response to word-pairs that were going to be presented on the screen (see Appendix 3.4). Participants were instructed at the beginning about the nature of the four operations they were to carry out. The instructions were presented in four different orders on the computer screen according to the counterbalancing format assigned to the participant. For the graphemic, phonemic and semantic study condition, participants received the same instructions as the participants in Experiment 3. However, for the fourth depth-of-processing manipulation, participants were instructed to create an interactive image of the two words and then decide for which one of the two words was easier to create an image. Participants were told that a set of instructions at the top of the screen will remind them what operation they would have to carry out for each word-pair set. Participants were told that they would have to carry out the same operation for a series of 28 word-pairs and then the instructions will change prompting them to carry out the next operation on the list with other word-pairs.

Word-pairs were presented in the same way as in Experiment 3 but this time for 6 seconds. Immediately below each word (directly in the middle of the word), there was a small empty circle on the screen as in Experiment 3. However, the response procedure was altered. In Experiment 3, the mouse click was used to select one of the words. As older adults have considerably more difficulty and less practice with mouse control, the type of response was altered to a simple key response. To select the word on the left, the first word, participants had to press the shift key which was labelled "Word 1". To select the word on the right, the second word, they were to press the apple key on the keyboard labelled "Word 2". When the participant could not make a selection, as the words were the same in respect to the study-task decision, they were to press the "option" key labelled "Same". As participants pressed any of these three keys the circle beneath each respective word became darker to indicate their selection. Participants were instructed that they had to make their selection within the 5 seconds during which the word-pair appeared. If they were to miss one trial then they were to just concentrate on the next trial. Participants had no difficulty to make their selection within these time limits.

Participants had then to carry out two distractor tasks. The nature, aim, and procedure of these tasks were identical to that in Experiment 3. At the end of the distractor tasks, approximately 10 minutes after the end of the study phase, the test phase began. In each of the younger and older adults group, twenty four participants were presented with intentional retrieval instructions and the other twenty four were presented with incidental retrieval instructions worded in the same way as Experiment 3 (see Appendix 3.4). The assignment to the two study conditions was randomly determined. In order to minimise voluntary retrieval in the incidental test, the study task was presented as another word association task, similar to the city and name tasks of the distractor phase. To emphasise this continuation, the presentation format of the study phase was identical to the two distractor tasks. The procedure of this study phase was identical to the study phase procedure of Experiment 3, except that only 168 word-pairs were presented in this phase. At the end of the study phase all participants were debriefed and then excused.

4.4 Results

A response was considered a target response only if the studied words and the words produced at test were identical. Both plural and singular versions of studied words were considered as target associations. Baseline association strength was calculated by the production by the participant of the selected word-pairs without the participant having studied the word-pairs. Each participant's score (young and old) and the score for each word-pair is reported in Appendix 4.4 and 4.5. The mean proportions of target associations are reported in Table 4.1.

TABLE 4.1

MEAN PROPORTIONS AND STANDARD ERRORS (SE) OF WORD ASSOCIATES THAT CORRESPONDED TO TARGET WORDS (STUDIED AND UNSTUDIED) AS A FUNCTION OF TEST INSTRUCTIONS, DEPTH OF PROCESSING AND ASSOCIATION STRENGTH FOR YOUNGER AND OLDER ADULTS AND PARTICIPANTS.

Younger adults

	Studied								*Unstudied*	
Association	*Graphemic*		*Phonemic*		*Semantic*		*Image*		*(Baseline)*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
					Incidental Test					
High	.64	.03	.73	.02	.76	.03	.78	.03	.60	.03
Low	.16	.02	.20	.03	.41	.03	.38	.04	.12	.01
					Intentional Test					
High	.15	.03	.31	.03	.84	.03	.80	.03	.02	.01
Low	.05	.01	.11	.02	.65	.04	.59	.04	.00	.01

Older adults

	Studied								*Unstudied*	
Association	*Graphemic*		*Phonemic*		*Semantic*		*Image*		*(Baseline)*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
					Incidental Test					
High	.66	.03	.67	.03	.72	.03	.74	.03	.59	.03
Low	.15	.02	.16	.02	.30	.04	.27	.04	.12	.01
					Intentional Test					
High	.06	.02	.15	.03	.66	.04	.61	.05	.02	.01
Low	.02	.01	.03	.01	.37	.05	.32	.05	.02	.01

The level of significance for all the following analyses was set at 0.05. A first analysis was carried out to check if significant priming was obtained in all conditions in the incidental test. By comparing target production of unstudied items with studied items for each of the four depth of processing tasks in younger and older adults, a significant priming effect was obtained following all study tasks. Priming was obtained following encoding processing promoted by the image study task [older adults: $F_{(1,23)} = 42.74$, $p<.001$; younger adults : $F_{(1,23)} = 68.94$, $p<.001$], the semantic study task [older adults: $F_{(1,23)} = 41.06$, $p<.001$; younger adults: $F_{(1,23)} = 75.80$, $p<.001$], and the phonemic study task [older adults: $F_{(1,23)} = 13.40$, $p=.001$; younger adults: $F_{(1,23)} = 36.20$, $p<.001$]. Contrary to the first study, graphemic study processing was also sufficient to promote priming in the older adults [$F_{(1,23)} = 5.21$, $p=.032$] but only approached significance in the younger adults [$F_{(1,23)} = 3.44$, $p=.076$]. This difference from Experiment 3, could be related to the longer study exposure of the word-pairs, allowing more opportunity for lexical access.

A second analysis was carried out to verify whether the instructions' manipulation had an effect. A 2x2x4x2 mixed ANOVA with age (young vs. old) and retrieval tests (intentional vs. incidental) as the between factors and depth-of-processing (graphemic, phonemic, semantic, and self related) and association strength (high vs. low) as within factor was carried out. The analysis showed that the manipulation of retrieval test produced significantly different retrieval performances ($F_{(1,92)} = 38.40$, $p<.001$). There was an overall significant effect of ageing ($F_{(1,92)} = 26.85$, $p<.001$) too. But, crucially, there was a retrieval test by ageing interaction ($F_{(1,92)} = 7.661$, $p=.007$) indicating that the age effect on retrieval performance was not the same in the two retrieval tests. There was also an overall significant effect of association ($F_{(1,92)} = 12.73$, $p<.001$) and depth of processing ($F_{(3,276)} = 295.20$, $p<.001$). More importantly there was a significant depth of processing by association by retrieval instructions interaction ($F_{(3,276)} = 15.35$, $p<.001$) indicating that the depth-of-processing effect on the two association strengths was different in the two retrieval tests. In addition, this interaction effect was the same in younger and older adults as the four way interaction (depth of processing by association, by retrieval test, and by age) was not significant ($F_{(3,276)}$ =.68, p=.564). The same results were obtained with the item analysis.

4.4.1 Incidental test

Data from the incidental test was analysed separately to elucidate the effect of age, depth of processing and association strength on priming. The analyses were carried out on retrieval magnitudes corrected for retrieval of unstudied word-pairs (or baseline). At the level of participants, the proportion of unstudied pairs was subtracted from the proportion of the studied pairs reproduced at test. This data (reported in Appendix 4.5) is shown in Figure 4.1.

A 2x2x4 mixed factorial design ANOVA with age as the between participant factor, and with association strength and depth of processing as within participants factors, was carried out. Older adults produced less studied pairs in the incidental test than the younger participants as the main effect of age was significant [$F_{(1,46)}$ = 4.80, p= .033]. There was also an overall significant main effect of depth of processing [$F_{(3,138)}$= 31.04, p< .001]. The effect of association strength was not significant [$F_{(1,46)}$ = .68, p= .414]. There was no significant age by depth of processing interaction [$F_{(3,138)}$ = 2.11, p= .101] indicating that depth-of-processing effects behave the same for both younger and older adults participants. More importantly, there was a depth of processing by association interaction [$F_{(3,138)}$ = 5.87, p= .001] indicating that word-pairs with high association strength were not as susceptible to depth-of-processing effects as the weakly related pairs. The three way interaction of age by association strength by depth of processing was not significant [$F_{(3,138)}$ = .63, p= .594] indicating that the depth of processing by association-strength interaction was equally present in both younger and older adults.

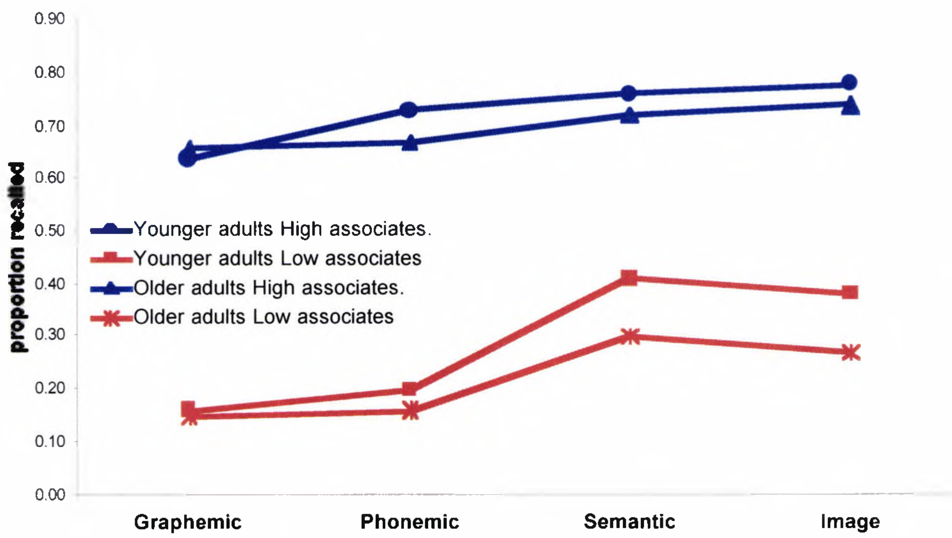
In this analysis the age by association interaction was not significant [$F_{(1,46)}$ = 1.19, p= .280] indicating that the older adults' deficit in priming was the same for both association strengths. However, planned comparisons between younger and older adults' involuntary retrieval showed that for the strongly associated words there was *no* age effect for all four levels of processing [graphemic: $t_{(46)}$ = .52, p=.60; phonemic: $t_{(46)}$ = -1.44, p=.16; semantic:

$t_{(46)}$=. -.62,p=.537; image: $t_{(46)}$= -.82,p=.417]. Instead, for the weakly related words there was an overall significant effect of age. Planned comparisons show that this effect was found for following semantic [$t_{(46)}$= -2.22 p=.03] and image study processing [$t_{(46)}$= -2.06 p=.04] and not following graphemic [$t_{(46)}$= -.32,p=.747] or phonemic study processing [$t_{(46)}$= -1.52, p=.136].

Planned comparisons were carried out to discern the effect of the four depth of processing tasks on priming. As can be seen in Figure. 4.1, planned comparisons showed that graphemic study processing of strongly related words conferred an overall disadvantage over phonemic [$t_{(47)}$ =.-2.09, p=.04] semantic [$t_{(47)}$ =-3.91, p<.001] and image processing [$t_{(47)}$ =-4.45, p<.001]. Semantic processing at study conferred an overall advantage over phonemic study processing for the weakly related pairs in the younger adults [$t_{(23)}$ = -6.26, p<.001] and in older adults [$t_{(23)}$ = -3.78, p=.001]. But, importantly this was not the case for the strongly associated word-pairs [younger adults: $t_{(23)}$ = -.74, p= .469; older adults: $t_{(23)}$ = -1.43, p= .166]. There was no significant difference in priming following semantic and image study processing of strong associates in both younger adults [$t_{(23)}$ = -.64, p=.530] and older adults [$t_{(23)}$ = -.33, p=.743] groups and for the weak associates [younger adults: $t_{(23)}$ = .91, p= .374; older adults: $t_{(23)}$ = 1.02, p= .317]. The identical trends were replicated in the item analysis.

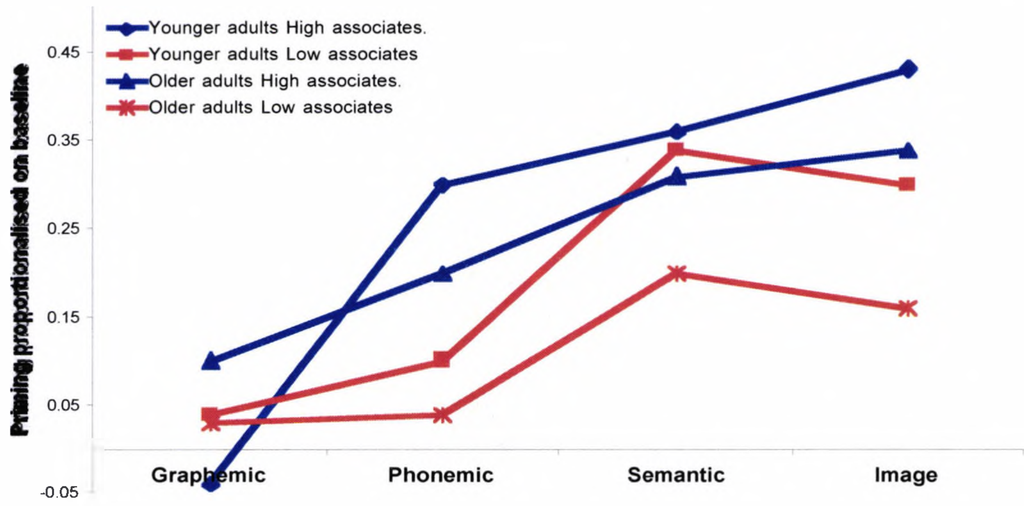
To summarise, the analysis and the planned comparisons showed that in the incidental test graphemic study processing promoted lower priming than any of the other processing study tasks. Instead, if we look at the difference between phonemic study processing compared to semantic study processing, a significant depth of processing effect was found only in the weakly associated word-pairs and not in the strongly associated word-pairs. Furthermore, older adults showed less priming than the younger adults for the weakly associated word-pairs, but not so for the strongly associated pairs.

FIGURE 4.1.
EXPERIMENT 4. INCIDENTAL TEST PERFORMANCE AS A FUNCTION OF AGE, ASSOCIATION STRENGTH AND DEPTH OF PROCESSING.



When there are baseline differences as with the strongly and weakly associated pairs it is also custom (Snodgrass, 1989; see also: Perez, Peynircioglu, & Blaxton, 1998) to take into account these differences by calculating priming proportionalised on what is left over from baseline completion, hence priming is divided by 1 minus baseline. These priming magnitudes can be seen in Figure 4.2. If we look at priming proportionalised on the baseline, a different picture emerges. An inspection of Figure. 4.2 shows that the same priming magnitudes obtained with strongly related words, were obtained for the weakly related words only when elaborative study processing was carried out. Furthermore, no age effect on incidental retrieval was reported (the details of this analysis are reported in Appendix 4.6). However, there were normal significant main effects of depth of processing and association strength. The depth of processing by association interaction approached significance. It is difficult to assess which priming magnitude and which results are the most appropriate when there are baseline differences. This issue will be addressed in the next experiment.

FIGURE. 4.2. EXPERIMENT 4. PRIMING MAGNITUDES PROPORTIONALISED ON BASELINE (STUDIED- BASELINE/1-BASELINE) AS A FUNCTION OF AGE, ASSOCIATION STRENGTH AND DEPTH OF PROCESSING.



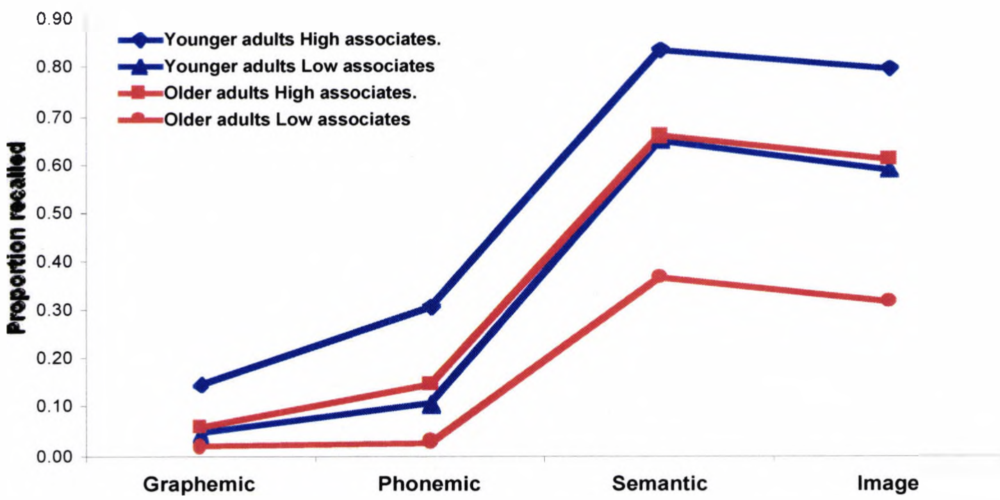
4.4.2 Intentional test

The correspondent 2x2x4 mixed factorial design ANOVA, with age as the between participant factor, and with association strength and depth of processing as within participants factors, was carried out for the *corrected* scores (at the level of participants, corrected scores were obtained by subtracting the proportion of unstudied pairs from the proportion of the studied pairs reproduced at test) in the intentional test. As can be seen from Figure 4.3, older adults recalled fewer studied word-pairs. This age effect was significant [$F_{(1.46)} = 26.20$, $p<.001$]. There was a significant main effect of depth of processing [$F_{(3.138)} = 309.35$, $p<.001$] and of association strength [$F_{(1.46)} = 214.58$, $p<.001$]. Contrary to the incidental retrieval test there was a significant age by depth of processing interaction [$F_{(3.138)} = 6.66$, $p<.001$]. This indicated that the advantage that younger adults had over older adults in recalling previously studied material was obtained mainly following deeper levels of processing at study. Shallow depth of processing did not confer more advantage to the younger adults' group over the older adults' group. Floor effects in retrieval following graphemic and phonemic processing may have been responsible for this. There was no significant age by association interaction [$F_{(1,46)} = .22$, $p=.640$] indicating that strength of association effects behave equally for younger and older participants.

The depth of processing by association interaction was significant [$F_{(3,138)} = 12.94$, $p>.001$] and this indicated that there was a different effect of depth of processing on the retrieval of word-pairs with different association strengths. However, differently from the incidental group, the dissociation was in the opposite direction, whereby the word-pairs with high association strength benefited more from deeper levels of processing than word-pair with lower association strength, especially when the interactive image processing task was concerned. Planned comparisons indicated that a depth of processing effect was present for both association strengths. Graphemic study processing conferred a disadvantage over phonemic processing in the weak [$t_{(47)} = -2.48$ $p=.017$] and strong associates [$t_{(47)}=-4.80$, $p<.001$]. Phonemic study processing conferred a disadvantage over semantic processing [weak associates: $t_{(47)}=-13.02$, $p<.001$; strong associates: $t_{(47)}=-19.03$, $p<.001$]. The three way interaction of age by association strength by depth of processing, was also significant [$F_{(3,138)} = 4.17$, $p=.007$] indicating that the depth of processing by association strength interaction was not equally present in the younger and older participants.

Image processing did not confer any significant advantage over semantic processing in the strong associates [$t_{(47)}= 1.67$ $p=.102$] and there was a suggestion in the data that it actually conferred a disadvantage on voluntary recall of the weak associates [$t_{(47)} = 1.91$, $p=.062$]. The same findings were reported in an item analysis.

FIGURE. 4.3.
EXPERIMENT 4. INTENTIONAL TEST PERFORMANCE AS A FUNCTION OF AGE, ASSOCIATION STRENGTH AND LEVEL OF PROCESSING.



4.4.3 Younger adults

Separate analysis were carried out on the corrected data (unstudied baseline subtracted) from the younger and older adults to further clarify the results obtained for the two different populations. A 2x4 repeated measure ANOVA with association strength and depth of processing as within participants factor was carried out on the young *incidental-test* scores. The analysis revealed a significant effect of depth of processing [$F_{(3,69)} = 22.42$, $p<.001$] and a non significant effect of association [$F_{(1,23)} = 1.94$, $p=.177$]. More importantly the dissociation between word-pairs with high association strength and pairs with low association strength was replicated as the depth of processing by association interaction was significant [$F_{(3,69)} = 5.66$, $p=.002$]. This interaction reflects the finding that strongly associated word-pairs are less susceptible to depth-of-processing effects than weakly associated words and replicates the finding from Experiment 3.

In the *intentional* test, the same analysis revealed a significant effect of association [$F_{(1,23)} =$ 137.24, $p<.001$] and a depth-of-processing effect [$F_{(3,69)} = 250.21$, $p<.001$] were found.

However, there was no significant interaction between association strength and depth of processing [$F_{(3,69)} = 1.88$, $p=.141$]. In the younger adults' group, by comparing involuntary with voluntary retrieval following semantic study orientation, higher retrieval magnitudes (.84) were obtained in the intentional test than in the incidental test (.76) with the strongly related words. However, this difference only approached significance ($t_{(47)} = -1.74$. $p=.09$) and hence no further evidence against ceiling effects in the incidental test for the highly related words was provided by these results.

4.4.2 Older adults

For the older adults, the results in the *incidental* test were less clear. There was a significant main effect of depth of processing [$F_{(3,69)} = 9.93$, $p<.001$] and not of association strength [$F_{(1,23)} =.03$, $p=855$]. However, there was no depth of processing by association interaction [$F_{(3,69)} = 1.30$, $p=.283$]. An inspection of Figure. 4.1 suggests that this lack of interaction was due to the smaller effect of conceptual elaboration on the low associates, and a slight, but not significant, effect of depth of processing in the strongly associated word-pairs. In the *intentional* test, there was a significant main effect of depth of processing [F (3,69) = 95.38, $p<.001$] and of association strength [$F_{(1,23)} = 86.11$, $p<.001$]. The depth of processing by association interaction [$F_{(3,69)} = 19.60$, $p<.000$] was significant.

4.5 Discussion

In the incidental test older adults showed overall less conceptual priming than the younger adults. However, this age effect in conceptual priming was marked only in the retrieval of weakly related word-pairs, following semantic or image processing at study. With strongly related pairs no effect of age was shown regardless of depth of study processing. In the intentional test the older adults also recalled fewer word-pairs than the younger adults overall. This age effect was present regardless of the association strength of the retrieved pairs. Furthermore, depth-of-processing effects were practically identical whether participants retrieved weakly related words or strongly related words. There is a suggestion in the data from the intentional test that older adults did not benefit as much as younger adults from elaborative processes, in particular for the weakly related word-pairs. However, they still showed an advantage of elaborative processing over graphemic and phonemic processing.

In the same way as experiment 3, graphemic level of processing at study was associated with lower voluntary and involuntary retrieval, except for the weakly related words as recalled by older adults in the intentional test. In this case no differences were found between pairs studied with the graphemic and the phonemic orienting task. Not a great importance was attributed to this finding as overall lower levels of recall were obtained for older adults in both these study tasks, therefore the null effect was attributed to a floor effect. Semantic and image study processing consistently conferred an advantage over phonemic and graphemic study processing. However, word-pairs studied with the image study task did not confer the expected advantage to voluntary retrieval. This lack of effect was probably due to the time restriction at study for carrying out the image orienting task.

In this experiment the same pattern obtained in Experiment 3 in the incidental test was replicated both in the younger and in the older adults. Retrieval of strongly associated words does not attract an advantage from the semantic encoding conditions over the phonemic encoding conditions. Instead, voluntary retrieval and involuntary retrieval of weakly associated words is affected by such manipulation.

The findings that older adults showed less priming in the case of weakly associated words, but the same priming as younger adults in the case of strongly associated words, in the same conceptual incidental task, has great theoretical importance. This finding may go someway to explain some of the conflicting results reported in the literature about the status (intact or impaired) of conceptual priming in older adults.

An overall age effect was found on conceptual incidental and intentional tests where the younger adults outperformed the older adults. This finding supports the processing view that argues that older adults are impaired in conceptual processing and the involuntary or voluntary nature of the retrieval task is irrelevant. Older adults' conceptual processing is impaired and therefore a deficit is revealed in both conceptual voluntary and involuntary retrieval. However, it was found that this age effect was mainly marked for the words that were weakly associated and not for the words that were strongly associated. This finding would suggest that involuntary memory is intact in older adults provided that the constituents of studied pairs are strongly associated. This dissociation within levels of association calls for another explanation for the deficit in involuntary retrieval for the low associates separate from a suggestion of an impairment of conceptual processes in the older adults.

The finding of a dissociation between the retrieval of strongly related and weakly related words within the same task also presents problems for the contamination hypothesis of incidental tests by voluntary retrieval strategies (e.g., Richardson-Klavehn & Bjork, 1988; Reingold & Toth, 1996; Toth & Reingold, 1996; Toth, Reingold, & Jacoby, 1994). If this was the case, the same depth-of-processing effects and age effects would be found for both word association levels in the same involuntary retrieval task. Other factors, independent of voluntary retrieval, are contributing to the pattern of these conceptual priming results.

The systems theory can better account for the dissociation by postulating a third system responsible for mediating performance in conceptual incidental tests, which is intact in older adults, and differs from the system that mediates performance in the intentional test, which is impaired in older adults. However, the system theory would have to specify why depth-of-processing effects are sometimes present and sometimes not in conceptual incidental tests.

The interpretation of the results developed in Chapter 3 also applies to the current results. Deeper level of processing, in the case of voluntary retrieval, has the role of establishing a representation and, in particular, helps the binding of the episodic context, that is, its spatial-temporal co-ordinates, to this representation (Bower, 1996). By contrast, in the case of involuntary retrieval, deeper level of processing also helps the building of a representation, but this time the context is irrelevant, as it is not part of the task demands. Following intentional retrieval instructions, the association between context and stimulus representation will modulate retrieval. Following incidental retrieval instructions, it is only the association between the stimuli that modulates retrieval. So, in involuntary retrieval, deeper level-of-processing at study confers no advantage to the involuntary recall of words with a familiar association. For less familiar associations instead, shallower levels of processing are less efficient in building an association and, as a result, a disadvantage is conferred at retrieval. In voluntary retrieval, where the association between context and the representation is more important, deeper level-of-processing will have the same effect on familiar or unfamiliar associations. Overall, weakly related words will be less well recalled.

Ageing has a different effect on the two retrieval tests. In the light of these results, it may be advanced that older adults have less effective encoding processes (see also Perfect & Das-gupta, 1997; Perfect, Williams, & Anderton-Brown, 1995). In voluntary recall, less efficient encoding processes at study are responsible for weaker connections between context and stimuli. Therefore, voluntary retrieval for the weakly associated words will be smaller than for the strongly associated words, but older adults' retrieval magnitudes would be smaller overall. Instead, in involuntary retrieval, where less efficient encoding is important only in the building of a more stable representation, this deficit will be expressed by the smaller priming magnitude only for the weakly associated words. Strongly associated words will not require effective encoding processes for priming to be fully expressed. Involuntary retrieval is intact in older adults. If a representation exists, young controls do not have an advantage over older adults in involuntary retrieval; it is only when they have to establish an unfamiliar association or make an association to the context in intentional tests that older adults are at a disadvantage.

One last point should be made about one limitation of the current data which puts in doubt the evidence for the above inferences. In a word association task where word association strength is manipulated, the difference between involuntary retrieval patterns for the strongly and weakly related associates, is intrinsically linked to the difference in association strength baselines. In the current data baseline differences, reflected in the priming magnitudes, could constitute a confounding factor that is responsible for the observed patterns. In the next experiment, this problem is addressed directly by empirically equating baselines but not the familiarity of the association between two words.

In summary, there is evidence that conceptual priming does not behave as voluntary memory as there is not a depth-of-processing or an age effect for word-pairs whose association is firmly represented in memory. It is argued that involuntary retrieval is unimpaired in older adults and is dissociable from voluntary retrieval. Involuntary retrieval is strongly dependent on the representation of the material to be recalled. A slight exposure to such material is sufficient to produce a priming effect. Instead, for word-pairs that are not so well represented in memory this representation needs to be established in order to be primed. Deeper levels of processing seem to engage an effective process for building such a representation. This depth-of-processing effect is though different from the effect on voluntary retrieval. In this case, meaning-based processing is responsible for establishing a connection between the words (hence there is an association strength effect) as well as with the spatial/temporal context in which the words were presented.

Chapter 5

Compound Representations and Conceptual Priming

Overview of Chapter 5

The experiments of the previous two chapters provided evidence that conceptual priming and conceptual voluntary retrieval can be dissociated. The differences in priming obtained by manipulating association strength better elucidate the properties and nature of conceptual priming. Conceptual elaboration at study can have an effect on both voluntary and involuntary retrieval. In voluntary retrieval, elaborative processes are responsible for establishing a stronger connection between the material presented at study and the spatial/temporal context of the presentation. In involuntary retrieval, elaborative processes have the function of facilitating the building of a compound representation incorporating both words. In the case of weakly associated words, this representation would be less well established in the first place. By contrast, in the case of strongly associated words, the representation is probably already a stable one as testified by the frequency of producing such associations in free-association tasks. If a representation is already stable, elaborative processing confers an advantage to voluntary but not involuntary retrieval. In this chapter the nature of the stimuli of which conceptual priming is unaffected by elaborative processing, is investigated further. Frequently co-occurring words in written and spoken language that form a two-word phrase (e.g., *hand-lotion, coat-hanger*) often found in word association norms. It was speculated that two-word phrases have a corresponding compound, more stable, representation. In this study, the involuntary and voluntary retrieval of two-word phrases were compared following the manipulation of study processing. Two-word phrases were selected to match the association strength of pairs constituted by semantically related words. This meant that baseline association was equated, but the *type* of association was manipulated and the two variables were not confounded as in Experiments 3 and 4 and previous experiment in the literature (e.g., Vaidya et al., 1997). This powerful design should solve the problems of the previous two experiments in relation to the calculation of the amount of priming, which was difficult to interpret because of different baselines between the strongly related words and the weakly related words. In the second experiment in this chapter, an inclusion test (Jacoby, Toth, & Yonelinas, 1993) is added that allows the equation of baseline across incidental and intentional tests. As predicted it was found that the priming of two-word phrases is also not affected by conceptual elaboration at study in the same way as strongly associated words. By contrast, the voluntary retrieval of the two-word phrases is affected by variation of depth of processing at study. From these experiments it can be concluded that the difference obtained in the effects of elaborative study processing in the incidental test is not an artefact of baseline differences.

5.1 Introduction

The results obtained in the previous experiments (Experiment 3 and 4) point in the direction of a dissociation between conceptual involuntary and voluntary retrieval. In involuntary retrieval, conceptual elaboration of strongly associated word-pairs at study did not confer a mnemonic advantage over strongly associated word-pairs studied with a phonemic study task. In voluntary retrieval by contrast, the usual depth-of-processing effect was observed for the strongly associated words. Furthermore, with the strongly associated words, older and younger adults exhibited similar levels of conceptual priming whereas, in voluntary retrieval, older adults were outperformed by the younger adults. The involuntary and voluntary retrieval of weakly associated words exhibited effects of study processing and age.

It is argued that involuntary retrieval is not affected by depth of processing at study when a pre-existing representation of the association between two words is primed. It is only when a compound representation of the two words needs to be established that depth of processing modulates the formation of the representation and its subsequent retrieval. It follows that involuntary retrieval of weakly related pairs, where a compound representation needs to be established, shows an effect of depth of processing. To test the scope of this hypothesis, the nature of a compound representation is probed further.

A study by Schacter and McGlynn (1989), mentioned in Chapter 1, found that conceptual priming could be observed for idioms (e.g., *sour-grape*), common in American English, following non-elaborative processing. Instead, for uncommon British idioms (e.g., *curtain-lecture*) priming could not be observed. The amount of priming for common idioms seemed independent from the orienting study tasks, apart from a study task requiring participants to come up with a definition of the idiom. (The finding of an advantage of the definition study-task is probably related to voluntary retrieval influences in the incidental test.) It has been proposed by Horowitz and Manelis (1972) that such idioms have a unitised memory representation (see also, Osgood & Hoosain, 1974). An idiom, in fact, can only be represented as an entity that is separate from its constituent words and therefore it requires a separate representation. Schacter and McGlynn (1989) argue that the idioms' unitised representation is automatically activated at study and this activation is expressed in priming.

The results of the Schacter and McGlynn (1989) study alert us to the importance of the type of association between words in modulating conceptual priming. However, the interpretation of the results of this study is limited by the following shortcomings. Firstly, involuntary and voluntary retrieval instructions were treated as a within participant variable. After the incidental test, participants carried out an intentional test, not allowing for the control of order effects. Secondly, direct comparisons of the effects of depth of processing on uncommon British idioms was limited by the absence of any priming following all the study conditions except the definition condition. Thirdly, related to this problem, baseline association strength between the words in the idioms could not be controlled.

It is here speculated that frequently occurring word pairings in written and spoken language could also be a special subset of associations with a corresponding pre-existing compound representation. A subset of word-pairs expressed in free association can be classed as pairs where the origin of the association is to be found in the temporal and spatial contiguity in both spoken and written language. Free association norms seem, somehow, to capture two qualitatively different associations. Sometimes a semantic association is elicited by the instruction of free associating to a cue word, and sometimes associations are elicited based on a frequent co-occurrence of the two words in spoken/written language. Word-pairs such as, *heart-beat, senior-citizen, washing-machine* are pairs constituted by semantically distinct words, but are yet very much associated by their usage in common language as phrasal expressions. The other subset of word-pairs expressed in free association can be classed as pairs where the origin of the association is to be found in the semantic relation between the two words. The words seem to be part of the same semantic domain with some overlap in meaning (e.g., *defence-attack, laundry-clothes*).

In this respect, words can be *strongly* associated but semantically dissimilar (e.g., baby-face) or words can be *weakly* associated but semantically very similar (e.g., strict-severe). Hence, *associative strength* seems orthogonal, rather than parallel, to *association type*. The orthogonal aspect of association strength to association type can be exploited in the design of the experiment. Phrasal expressions with a putative compound representation could be compared with word-pairs which do not have a compound corresponding representation, without the confounding factor of different association strength baselines. Two sets of word-pairs can be constructed with similar association strength, as indexed by free-association norms, but with different association types. In the following experiments, word-pairs that constitute a phrasal expression are compared with word-pairs whose constituent words are associated by a semantic relationship but are matched on association strength.

The terms "two-word phrases" and "compound" representation are used here rather than the earlier terms of "idioms" and "unitised" representation (Hayes-Roth, 1977; Schacter, 1985). This is because the term "two-word phrases" include a much larger category of word-pairs than the category of words indicated by the earlier terms. With idioms (e.g., *sour-grapes*) the meaning of the word pair cannot be directly derived from the meaning of its constituent words, the fusion of the two words give rise to a distinct meaning with a putative separate representation termed "unitised". The two-word phrase does not have to be represented as a separate entity from the two constituent words as in idioms, e.g. a *heart-beat* is still semantically related to its constituent words *heart* and *beat* and the two-word phrase does not mean something separate from a beat of the heart. The corresponding representation is still related to the representation of the two constituent words, the two words are more bound by an adjectival relationship where the head noun (*beat*) is modified by another noun (*heart*). The term "compound" representation is here used to refer more generally to a representation that *tightly links* the two words in a pair together, but makes no claim on the representation standing alone, or being semantically separate from its constituents words (but see Osgood & Hoosain, 1974). In this way, the term "compound" can also be applied to the representation of *strong* semantic associates. The only criteria in the selection of two-word phrases was that these phrases were reproduced in word association norms and the two words appeared contiguously in spoken/written language.

In summary, there are both theoretical and methodological advantages of looking, in the next experiments, at word-pairs that constituted a phrasal expression. One theoretical advantage is that our understanding of the nature of the pairing that in conceptual involuntary retrieval is not susceptible to elaborative processing effects is expanded. Secondly, phrasal expressions can be directly matched on association strength with semantically related words and the important confounding factor of baseline differences in the earlier experiments can be controlled. Thirdly, by selecting phrasal expressions with a lower baseline than the one previously used for the strong associates, we are able to avoid the problem of ceiling effects, which constrained the interpretation of the previous findings.

5.2 Experiment 5a

5.3 Method

5.3.1 Participants, Design and Materials

The participants were forty-eight students from City University who did not take part in any of the other experiments on word association. The students were either paid for their participation or participated for partial fulfilment of course credits. The experiment was a 2x2x2 mixed factorial design, with test instructions as the between-participants variable with two levels (incidental vs. intentional), and depth of study processing and association type as within-participant variables with two levels (phonemic vs. semantic, two-word phrases vs. weak associates, respectively). Participants were randomly assigned to the two test conditions with twenty-four participants in each group. At study, each participant did both the phonemic and semantic study tasks. Half of the participants in each retrieval instructions group did the phonemic study task first and the other half did semantic study task first. (See Design in Appendix 5.1.)

The materials consisted of 120 word-pairs selected from the Birkbeck Norms (Moss & Older, 1996). Half of the pairs were selected so that the first constituent word (the cue word) elicited, most frequently, the production of a word that was associated by temporal/spatial contiguity in spoken/written language (e.g., *shop-front, gas-fire, theme-park*). (See Appendix 5.2 where all the material used is reported in a table). The most frequent associate of the cue word was always selected. Only two-word phrases of low association strength were selected so that they could be matched with other word-pairs of low association strength. The matched word-pairs of low association strength were chosen adopting the same criteria as in Experiment 3 and 4. Pairs were selected if there was a semantic relationship between the constituent words. The words in these pairs tended to be synonyms or opposites. These word-pairs did not constitute a phrase, usually a conjunctive word would be needed to connect the two words so that they could produce a phrase.

For each phrase, a correspondent "semantic" word-pair with matched association strength was selected (see Appendix 5.2). For each association type, 60 word-pairs were selected. Association strength for these two sets of word-pairs ranged between 09% to 35%; the mean association strength was 19% for both sets (see Appendix 5.2). The 120 word-pairs were divided systematically into four lists of 30 word-pairs each with very similar mean association strength at around 19% (see Appendix 5.3). Of these 30 word-pairs, 15 were two-word phrases and the other 15 were pairs with matched low association strength.

The study lists were presented in a fixed random order. Each participant saw in total two lists of 30 word-pairs, one for each of the two orientation tasks. At test all the 120 word-pairs were presented in a different random order for each participant. These included the two studied lists plus two unstudied lists of 30 word-pairs each. The studied/unstudied status of the four lists was rotated according to a 4x4 Latin square (see Appendix 5.1).

An Apple Macintosh PowerBook (1400c) computer - programmed in the HyperCard environment - was used to present all the stimuli used in the experiment as well as to collect participants' responses.

5.3.2 Procedure

Each participant was tested individually. Participants were naïve to the purposes of the experiment and were only told that they would carry out a set of verbal tasks. In the study phase participants were seated in front of the portable computer and were shown the instructions on the computer screen (see Appendix 5.1). Participants were told that they would carry out two simple decisions in response to word-pairs that were going to be presented on the screen. In the phonemic study task, participants were instructed to decide which one of the two words had more syllables. In the semantic study task, they were instructed to decide which one of the two words had the most pleasant meaning. A set of instructions at the top of the screen will remind them which decision they would have to carry out for each word-pair list. Participants were told that they would have to carry out the same operation for a series of 30 word-pairs and then the instructions would change prompting them to carry out the second decision task with the next set of 30 word-pairs.

Word-pairs were presented in the middle of the screen, on the same line, with the first word - the cue word - presented on the left side of the screen and the second word - the target word- presented on the right side of the screen. The two words were at a third of an inch apart and a dash was placed between the two words. Word-pairs were presented on the screen for three seconds and the inter-stimuli interval was of 1 second.

The procedure for selecting the word was identical to that of Experiment 4. After the study phase, participants had to carry out one distractor for a duration of approximately seven minutes. This task was identical to the second distractor task of Experiment 3 and 4, where participants had to generate the first surname that came to mind in response to a first name presented as a cue. This distractor task had the function to familiarise the participant with the word association task and to minimise the chance of contamination from a voluntary retrieval strategy in the incidental test.

At the end of the distractor task, the test phase began. Twenty-four participants were presented with intentional test instructions and the other twenty-four were presented with incidental test instructions (see Appendix 3.4). The assignment to the two study conditions was randomly determined. The procedure of the test phase was identical to the procedure of Experiment 3 and 4. At the end of the test phase all participants were debriefed and then excused.

5.4 Results and Discussion

A response was considered a target response only if the studied words and the words produced at test were identical. Both plural and singular versions of studied words were considered as target associations. Baseline association strength was calculated by the production by the participant of the selected word-pairs without the participant having studied the word-pairs. The raw data for each participant and for each item are reported in Appendix 5.4 and 5.5 respectively. The mean proportions of target associations are shown in Table 5.1.

TABLE 5.1

MEAN PROPORTIONS AND STANDARD ERRORS (SE) OF WORD ASSOCIATES THAT CORRESPONDED TO TARGET WORDS (STUDIED AND UNSTUDIED) AS A FUNCTION OF TEST INSTRUCTIONS, DEPTH OF PROCESSING AND ASSOCIATION STRENGTH.

Association	*Studied*				*unstudied*	
	Phonemic		*Semantic*		*(Baseline)*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*
	Incidental Test					
Two-word phrases	.40	.02	.43	.03	.18	.01
Weak associates	.31	.03	.45	.04	.19	.02
	Intentional Test					
Two-word phrases	.16	.03	.58	.04	.00	.00
Weak associates	.12	.02	.64	.05	.00	.00

The level of significance for all the following analyses was set at 0.05. The baselines for the two-word phrases (M=18, SE= .01) and for the weakly related pairs (M=.19, SE=.02) did not differ significantly [T (23)= -.45, p= .658]. A first analysis was carried out to check if significant priming was obtained in all conditions in the incidental test. By comparing target production of unstudied items with studied items for each of the two depth of processing tasks, a significant priming effect was obtained for both types of associations following both the phonemic [$F_{(1,23)}$ = 58.98, p<.001] and semantic study task [$F_{(1,23)}$ = 59.81, p<.001]. Priming was measured by subtracting proportion of unstudied target words from the proportion of studied target words individually for each participant. scores are shown in Table 5.2.

TABLE 5.2

MEAN PROPORTIONS AND STANDARD ERROR (SE) OF CONCEPTUAL PRIMING (UNSTUDIED BASELINE SUBTRACTED) AS A FUNCTION OF DEPTH OF PROCESSING AND ASSOCIATION TYPE.

Association	*Phonemic*		*Semantic*	
	Mean	*SE*	*Mean*	*SE*
Two-word phrases	.22	.02	.25	.03
Weak associates	.11	.03	.26	.04

A second analysis was carried out to verify whether the test-instruction manipulation had an effect. A 2x2x2 mixed ANOVA with test instructions (intentional vs. incidental) as the between variables and depth-of-processing (phonemic, semantic) and association strength (two-word phrases vs. weak associates) as within variables was carried out. The test-instruction manipulation did not to have a significant effect [$F_{(1,46)} = .56$, $p=.458$]. There was an overall depth of processing effect [$F_{(1,46)} = 145.71$, $p<.001$]. However, importantly the depth of processing main effect was qualified by a significant interaction with the instruction manipulation [$F_{(1,46)} = 65.89$, $p<.001$] indicating that depth of processing effects were different in the intentional and incidental test. There was no significant effect of association type [$F_{(1,46)} =.40$, $p=.531$] or an association type by instruction interaction [$F_{(1,46)} = 1.32$, $p= .257$]. The interaction of depth of processing and association type was significant [$F_{(1,46)} =.11.80$, $p=.001$] indicating that the two association types were differentially susceptible to depth of study processing. However, this was the same in the intentional and incidental test, as the three way interaction was not significant [$F_{(1,46)} =.08$, $p=.775$]

The analysis showed that there was no effect of instructions, this problem is addressed in the next experiment (Experiment 5b). However, the presence of a significant depth of processing by manipulation interaction testified that the tests tap two different forms of memory, hence, in order to clarify the interaction of depth-of-processing effects with association type, separate analyses were carried out on the data from the incidental and intentional test.

A 2x2 repeated measure ANOVA with depth of processing and association type as the within participant variables, was carried out on corrected scores from the 24 incidental-test participants. The analysis revealed an overall significant depth-of-processing effect [$F_{(1,23)}=8.76$, $p=.007$]. No effect of association type was though found [$F_{(1,23)}=3.23$, $p=.086$]. More importantly, the interaction of association type and depth of processing was significant [$F_{(1,23)}=7.56$, $p=.011$]. This interaction occurred due to a significant depth-of-processing effect on word-pairs with low association strength [$t_{(23)}=-3.78$, $p=.001$] and a non-significant effect on word-pairs that constituted a phrase [$t_{(23)}=-.97$ $p=.344$]. The identical patterns were obtained on priming proportionalised on baseline.

The same 2x2 repeated measures ANOVA (with depth of processing and association type as within variables) was carried out on the corrected data of the intentional test participants. This analysis revealed a significant effect of depth of processing [$F_{(1,23)} = 184.03$, $p< .001$] in the intentional test. There was no significant effect of association type [$F_{(1,23)} = .13$, $p= .726$] showing that in voluntary retrieval one type of association confers no mnemonic advantage over the other. This differs from the previous studies where pairs whose constituents were strongly related were recalled better than weakly related pairs. The association type by depth of processing interaction was just significant [$F_{(1,23)} = 4.57$, $p= .043$]. This interaction was qualified by a difference in the depth-of-processing effect: The effect was slightly less for the two-word phrases than for the weakly related word-pairs. But, more importantly, the depth-of-processing effect was significant in both the word-pairs with low association strength [$t_{(23)} = -.12.15$, $p= .001$] and word-pairs which constituted a phrase [$t_{(23)} = -.10.45$ $p= .001$]. It is possible that this interaction effect was related to involuntary retrieval influences in the intentional test.

In the incidental test, the results from the previous two experiments were replicated. Elaborative processes at encoding did not affect conceptual priming for established associations, such as associations between words strongly related in meaning and between words related to each other by frequent spatial and temporal contiguity in written and spoken language. However, elaborative processes at encoding have a marked effect when such associations are retrieved voluntarily. For less familiar associations, with a less stable corresponding representation, elaborative processing effects are evident both in voluntary and involuntary retrieval.

The dissociation within the incidental test for different type of associations, reinforces the proposals put forward in the previous chapters on the role of meaning-based processing in involuntary retrieval. With the current results, the suggestions are put on firmer grounds as the interpretations of the previous results were clouded by baseline differences, endemic in the incidental version of the word association task. With the methodology adopted in the current experiment, where baselines are equated and are set at a low level to control for ceiling effects, stronger inferences can be made. From the current results it can be asserted that the lack of depth-of-processing effect on word-pairs with an established association, and a putative compound representation, is a real phenomenon and not an artefact of ceiling effects.

The effects of meaning-based processing can be better discerned with this method, by directly comparing these effects, without correcting for baseline differences between association types. Incidental test performance does not significantly differ between the two-word phrases and the matched low associates following semantic processing at study [$t_{(23)} = -.86$, $p=.399$]. Instead there is a significant difference following phonemic processing [$t_{(23)} =2.84$, $p=.009$]. This result implies that phonemic processing confers a disadvantage to involuntary retrieval and priming is not fully expressed. Instead, meaning-based processing enables the building of an integrated representation so that priming levels are equal to levels of priming with already stable associations.

This experiment however, still leaves one methodological problem. It could be argued that the differences obtained between the performance in the incidental and intentional tests are due to baseline differences between these two tests. The suggestion is that a depth-of-processing effect in the incidental test is obfuscated by high baseline association performance. Should baseline performance between the intentional and incidental test be equated, meaning-based processing may not be sufficient to confer an advantage over shallower processing in the voluntary retrieval test. Reingold and Toth (1996) and Toth, Reingold and Jacoby (1994) have argued that, contrary to what is professed by the retrieval intentionality criterion (Schacter et al., 1989), "response bias" across incidental and intentional test is not equated. Response bias changes when participants in incidental tests have to produce a response to all the retrieval cues whereas participants in the intentional test do not. This last problem is addressed in the following experiment.

5.5 Experiment 5b

Intentional test instructions in the previous three experiments prompted participants to produce the associated words to the cue word, only if they remembered the target associated words and they were sure that the pair replicated the studied one. If they saw a cue word that they did not recognise or they could not remember its studied associate, participants were instructed to pass the trial and not to attempt to guess. This procedure results in not coming up with an associate for unstudied word-pairs. Consequently baseline completion is close to zero. A higher baseline would indicate that the participant was guessing or generating the first word that came to mind rather than attempting to retrieve the associated word from memory. As the aim in the previous three experiments was to minimise the influence of involuntary retrieval, guessing was discouraged.

A different method can be used to equate baselines and response bias between the intentional and incidental test. Participants can be encouraged to engage in voluntary retrieval in the first place, then should the strategy fail, the participant is asked to free-associate to the cue word. When an unstudied cue word is presented, the participant has to produce the first word that comes to mind; in this way intentional test baseline comes to resemble incidental test baseline.

This kind of set up is equivalent to what has been termed an "inclusion" condition within the process-dissociation framework developed by Jacoby and his co-workers (Jacoby et al., 1993). According to Jacoby's process dissociation framework (see Chapter 1), an inclusion condition allows automatic and controlled influences on memory to act in concert. In this experiment the use of an inclusion condition is simply exploited to remove the confounding factor of the difference in baseline between the intentional and the incidental tests (Richardson-Klavehn & Gardiner, 1995, 1996). If baseline differences are critical, then retrieval in the incidental and inclusion tests should be similar and the tests should not dissociate. If baseline differences are not critical retrieval performance in the inclusion test should be similar to that of the intentional test. There is evidence that depth-of-processing effects are still found in an inclusion test of stem-completion but not in the incidental version of the test when baselines between the two tests were equated (Richardson-Klavehn & Gardiner, 1996,1998). It is predicted that, even with baselines equated, a depth-of-processing effect will still be observed for the two-word phrases following inclusion test instructions. Should a difference not be present, the result would suggest that the dissociations previously observed between involuntary and voluntary retrieval performances were attributable to baseline differences.

5.6 Method

5.6.1 Participants, Design and Material

The participants were additional sixteen students from City University, who did not take part in any of the other previous experiments. The experiment was a 2x2 repeated measure design, with depth of study processing and association type as a within-participants variable with two levels (phonemic vs. semantic and two-word phrases vs. weak associates respectively). At study, each participant did both the semantic and phonemic processing tasks. Half of the participants was administered the phonemic study task first and the other half was administered the semantic study task first (see Design in Appendix 5.1). The same word-pair lists and the same counterbalancing procedure as in Experiment 5a were adopted. (See Appendix 5.2 and 5.3.)

5.6.2 Procedure

The procedures of the study phase and of the distractor task were identical to those of Experiment 5a. At test, all participants were given "inclusion" retrieval instructions (see Appendix 5.6). Participants were told that their task was to use the words on the screen as cues to remember the associated word that they saw in the study tasks. Participants were told that they were not expected to be able to remember the associated word of all the words they were to see, as some of these words did not correspond to the words presented at study. If they remembered the associated word, they were to say that associated word. However, if they were to find that they could not remember seeing the word before, or could not recall the associated word, then participants were instructed to say the first word that came to mind. But, in the first place, participants were encouraged to try as hard as possible to remember the word-pair they saw in the study task. Apart from the set of test instructions, the rest of the procedure was identical to the incidental procedure of Experiment 5a.

5.7 Results and Discussion

As in all the other experiments, responses were considered target responses only if the studied words and the word produced at test were identical. Both plural and singular versions of studied words were considered as target associations. Baseline association strength was calculated by the production of the selected word-pairs, without the participant having studied the word-pairs. The raw data for each participant and for each item are shown in Appendix 5.7 and 5.8. The mean proportions of target associations, following inclusion instructions, are reported in Table 5.3. For ease of comparison with the results from Experiment 5a, incidental and intentional conditions from Experiment 5a are also reported.

TABLE 5.3

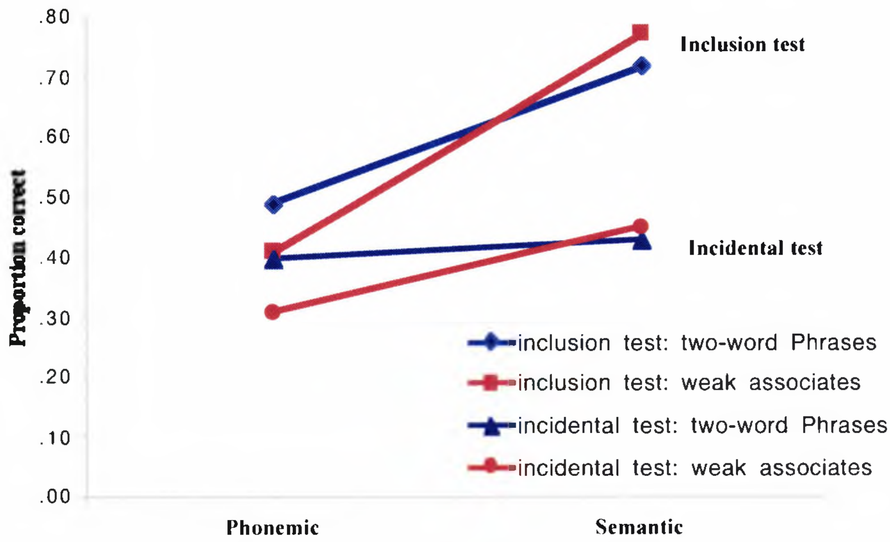
MEAN PROPORTIONS AND STANDARD ERROR (SE) OF WORD ASSOCIATES THAT CORRESPONDED TO TARGET WORDS (STUDIED AND UNSTUDIED) AS A FUNCTION OF DEPTH OF PROCESSING AND ASSOCIATION TYPE.

	Studied				*Unstudied*	
Association	*Phonemic*		*Semantic*		*(Baseline)*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*
Experiment 5b						
	Inclusion Test					
Two-word phrases	.49	.03	.72	.04	.20	.01
Low associates	.41	.05	.77	.04	.20	.01
Experiment 5a						
	Incidental Test					
Two-word-phrases	.40	.02	.43	.03	.18	.01
Low Associates	.31	.03	.45	.04	.19	.02
	Intentional Test					
Two-word-phrases	.16	.03	.58	.04	.00	.00
Low Associates	.12	.02	.64	.05	.00	.00

A 2x2 repeated measure ANOVA was carried out on the data (corrected for baseline) from the inclusion participants, with depth of processing with two levels (phonemic vs. semantic) and associations type with two levels (two-word phrases vs. weak associates) as the within participant variables. The analysis revealed that the main effect of depth-of-processing effect was significant [$F_{(1,15)} = 53.63$, $p < .001$]. As before, the main effect of association type was not significant [$F_{(1,15)} = .35$, $p = .560$]. The interaction of association type and depth of processing was not significant (although approaching significance) in this analysis [$F_{(1,15)} = 3.68$, $p = .074$]. Again, this possible interaction is caused by a semantic processing conferring more advantage to the retrieval of weak associates than to the retrieval of two-word phrases. And, more importantly, both types of word-pairs showed significant depth-of-processing effects [two-word phrases: $t(23) = -4.4$ $p=.001$; low associates: $t(23) = -6.9$ $p=.000$].

Direct comparisons can be made with the incidental test of Experiment 5a as baselines with the inclusion test were equated. Figure 5.1 combines the results from the incidental condition of Experiment 5a and the inclusion condition of Experiments 5b.

FIGURE 5.1.
EXPERIMENT 5A.B. INCLUSION AND INCIDENTAL TEST RETRIEVAL AS A FUNCTION OF DEPTH OF PROCESSING AND ASSOCIATION TYPE (TWO-WORD PHRASES OR WEAK ASSOCIATES)



A first comparison was made on baseline performance between the two tests. A 2x2 mixed ANOVA was performed with test instruction (incidental vs. inclusion) as the between variable and association type (two-word phrases vs. weak associates) as the within variable. No main effects of test instructions [$F_{(1.38)} = .55$, $p= .463$] and association type [$F_{(1.38)} = .14$, $p= .713$] were found, as well as a non-significant interaction [$F_{(1.38)} = .02$, $p= .891$], attesting to a successful matching of baseline, across association types and across incidental/inclusion tests.

A 2x2x2 mixed ANOVA, with depth of processing and association type as within variables and test instructions as between variable was also carried out on corrected scores to verify whether the manipulation of instructions had an effect. In this analysis a main effect of test instructions [$F_{(1,38)} = 30.79$, $p < .001$] was now significant. An overall significant depth of processing effect was found [$F_{(1,38)} = 58.51$, $p < .001$], but this effect was qualified by a significant interaction of depth of processing with test instructions [$F_{(1,38)} = 15.72$, $p < .001$] indicating that depth of processing had different effects on retrieval performance from the two incidental and inclusion tests. No main effect of association type was found [$F_{(1,38)} = 2.44$, $p = .127$], as well as a non-significant association type by test instructions interaction [$F_{(1,38)} = .30$, $p = .590$]. The important association type by depth of processing interaction was significant [$F_{(1,38)} = 10.58$, $p = .002$], showing that the effects of study processing differed for the two association types. However, the three-way interaction with test instruction [$F_{(1,38)} = .02$, $p = .896$] was not significant, indicating that the association type by depth of processing interaction is found for both types of test instructions. There is still though a difference between the incidental and inclusion test in relation to the association type by depth of processing interaction. In the incidental test, as reported in the earlier result section, a significant depth-of-processing effect was reported on word-pairs with low association strength and the effect was not significant on the two-word phrases. By contrast, in the inclusion task, as reported above, both types of word-pairs showed significant depth-of-processing effects.

5.8 General Discussion

In the incidental test, a depth-of-processing manipulation had an effect only on the primed semantic associates but not on the primed two-word phrases. Following semantic study processing, priming magnitudes of the semantic associates were equal to priming magnitudes of the two-word phrases. By contrast, following phonemic processing at study, association type determined priming magnitude: word-pairs that constituted a phrase showed normal priming magnitudes, whilst pairs whose constituents were semantically related, showed a deficit in priming. This result shows that the dissociation obtained in the previous experiments between the two association types (strong and weak) is not an artefact of differences in baseline across association types. In the intentional and inclusion tests, a depth-of-processing manipulation had a significant effect on both types of word-pairs. Thus, a dissociation was revealed between the two retrieval tests under otherwise identical conditions. Furthermore, the results from the inclusion test showed that the dissociation is not an artefact of response bias (or baseline differences) across tests. This finding confirms the importance of the voluntary/involuntary dichotomy in the understanding of memory function.

These results argue against the voluntary contamination hypothesis of incidental tests, as depth-of-processing effects on the intentionally retrieved two-word phrases were still apparent when baselines were equated, dissociating the voluntary retrieval strategy from the involuntary one for the two word phrases. However, parallel effects of depth or processing on the weak associates in the incidental, intentional and inclusion test could signal contamination of the incidental test. This argument though would imply the unlikely possibility that participants could discriminate at test between the randomly presented retrieval cues for the weak associates from the cues for the two-word phrases, and would be selective in their engagement of a voluntary and involuntary retrieval strategy, respectively.

The results obtained further support the suggestion made in the previous chapters that depth-of-processing effects in the incidental and intentional tests are of a different nature. In the incidental test an advantage of deeper study processing is conferred to less familiar associations without a stable, compound representation. Instead, the advantage conferred by deeper levels of processing to intentional tests, has to do with the facilitation in building at study a representation that includes the association between the words in the pair as well as the binding of the associations to the spatial/temporal context of the study episode. During voluntary retrieval, it is those representations that are bound to the context that satisfy the retrieval demands of the task. Therefore pairs that are conceptually elaborated at study are better retrieved than pairs studied engaging more shallow processes.

Chapter 6

Modality, Association and Consciousness

Overview of Chapter 6

The aim of the following experiment was two-fold. In the first instance it aimed to check whether involuntary retrieval of word-pairs, where the constituent words form a phrase, was mediated by perceptual rather than conceptual processes. The association between words that frequently co-occur in language can form an integrated perceptual gestalt. Presenting the cue word at test would be equivalent to presenting a degraded stimulus in perceptual priming tasks. Such involuntary retrieval would simply be a special case of perceptual involuntary retrieval which, in general, is left unaffected by depth-of-processing manipulations at encoding. To verify whether perceptual processes mediated the priming of two-word phrases in the previous experiment, a modality manipulation was employed. A modality effect is usually reported in perceptual incidental memory but not in conceptual incidental memory (e.g., Blaxton, 1989; Srinivas & Roediger, 1990; Carlesimo, 1994; Vaidya et al., 1995, 1997), attesting to conceptual priming being dissociable from perceptual priming as it relies on modality independent representations. The reliance of the priming of two-word phrases on perceptual processes would explain the dissociation obtained between the weak associates and the two-word phrases, as weak associates are unlikely to form an integrated perceptual gestalt. In the experiment, a small modality effect was found for both association types as well as in both voluntary and involuntary retrieval. The pervasive modality effect clouds the interpretation of the results. However, the lack of a larger modality effect for the two-word phrases over the weak associates in involuntary retrieval grants the broad conclusion that conceptual priming is mediated by *modality-independent* representations. The second aim of this study was more exploratory. A first attempt was made to investigate the relationship between cross-modal priming and conceptual priming, in the extent to which conceptual priming reflects involuntary but conscious memory, as in cross-modal priming (Richardson-Klavehn & Gardiner, 1996; Richardson-Klavehn, Clarke, & Gardiner, 1999).

6.1 Introduction

One of the distinctive feature of conceptual priming is that it dissociates from perceptual priming in the extent to which it is affected by perceptual overlap between study and test. Perceptual priming is classified as perceptual because it varies as a function of the perceptual match between the prime and the target. When this match decreases, by for example presenting the prime in auditory form at study and priming is tested with visually degraded stimuli, or the other way round, priming is reduced (e.g., Challis & Sidhu, 1993; Jacoby & Dallas, 1981; Richardson-Klavehn & Gardiner, 1996). This kind of finding reinforced the hypothesis, within the systems' perspective, that priming depends on the operation of modality-specific PRSs (Tulving & Schacter, 1990), probably involved in perceptual analyses which is not susceptible to volitional control. The modality specific systems process and retain a pre-semantic, structural record of the attended stimuli (Kirsner & Dunn, 1985; Moscovitch, 1992, Moscovitch & Umilta, 1990, 1991; Schacter 1990; Tulving & Schacter, 1990). Within the processing approach, modality effects reinforced the hypothesis that priming tasks tap data-driven (or perceptual) processes, whilst intentional tasks tap conceptually driven processes.

Modality effects in conceptual priming have been extensively investigated as the modality manipulation dissociates conceptual involuntary retrieval from perceptual involuntary retrieval and the modality variable is usually employed as a manipulation check. In fact, conceptual priming, in general, is left unaffected by manipulations of modality, reinforcing the hypothesis that this type of priming relies on modality independent representation systems or processes (e.g., Blaxton, 1989; Srinivas and Roediger, 1990; Carlesimo, 1994; Vaidya et al., 1995, 1997).

It is debatable whether priming, in a word association task, is mediated by a perceptual system/process. In principle, records of associations can be either structural, where a perceptual contiguity is relevant, or semantic, where conceptual relatedness mediates the representation of the association. In studies of involuntary retrieval, the reconstruction at test of the studied word-pair could be mediated by perceptual representations that integrate the two words in one perceptual gestalt.

In the experiment of the previous chapter, priming of paired associates that constituted a phrase were compared with priming of paired associates (matched on association strength) which were weakly connected but which did not form a phrase. Elaborative processes at study were found to have an effect on the involuntary retrieval of the semantic associates but not on the two-word phrases. In the intentional test, this effect was obtained irrespective of association type. The dissociation between incidental and intentional test performance was attributed to a difference in conceptual involuntary and voluntary retrieval. However, it is possible to argue that the priming of two-word phrases constitutes a special form of perceptual involuntary retrieval. If this was the case, then the lack of depth-of-processing effects in involuntary retrieval is explained by the retrieval of perceptual records which is usually unaffected by depth of study processing manipulations.

To verify whether the priming of two-word phrases (and, by extension, of the strong associates that behaved in a similar manner) is mediated by perceptual rather than conceptual processes/system, modality of presentation was manipulated, holding test modality constant (i.e. visual). It was reasoned that the priming of weak associates is less likely to be mediated by perceptual processes as the perceptual contiguity would have to be learned at study and this would not be supported by previous experience. Furthermore, weak associates displayed elaborative processing effects. In this scenario, if the priming of the two-word phrases relied on perceptual processes, a modality effect would be verified for the involuntary retrieval of this type of association and not for the weak associates. Study-test modality shifts were expected not to affect voluntary retrieval as found by Blaxton, (1989. But see: Gathercole & .Conway, 1988; Jacoby & Dallas, 1981; Craik, Moscovitch, & McDowd, 1994; Richardson-Klavehn & Gardiner, 1996.)

The second aim of this study was to look at the relationship between cross-modality priming, conceptual priming and consciousness. Although perceptual involuntary retrieval is believed to be mediated by a perceptual system/process, reliable cross-modality priming, where there is not a modality match between the prime and the target, is often observed (e.g. Rajaram & Roediger, 1993; Richardson-Klavehn, Clarke, & Gardiner, 1999; Richardson-Klavehn & Gardiner, 1996). One possible explanation for such cross-modal effects is that there is some amodal, intentional and conscious recollection component that operates in incidental tasks: in other words involuntary retrieval is contaminated by a voluntary retrieval strategy (Jacoby, Toth, & Yonelinas, 1993; Toth & Reingold, 1996)

However, Craik, Moscovitch, and McDowd (1994) reasoned that if conscious contamination explains cross-modality priming, this priming would show an effect of depth of processing. In their study the auditory priming magnitude was not affected by conceptual manipulations. Richardson-Klavehn and Gardiner (1996) also rejected the contamination hypothesis and put forward the alternative hypothesis that cross-modal priming is still involuntary but at the same time it is associated with an awareness of encountering the prime at encoding, and speak of involuntary conscious retrieval. To investigate the contamination hypothesis, they compare results obtained from the PDP (Jacoby, 1991) technique with results that satisfied the retrieval intentionality criterion (Schacter et al., 1989). Richardson-Klavehn and Gardiner (1996) adopt an on-line recognition technique, whereby participants are instructed to engage in involuntary retrieval but have to indicate whether they consciously recollect the product of their involuntary retrieval. They found that depth of processing had an effect in the intentional test but not in the incidental test for both within modality and cross-modality priming. However, cross-modality priming, which showed some reduction over within modality priming, was always accompanied by conscious awareness. Only within modality priming shows evidence of involuntary unconscious memory, but cross-modality priming reflected involuntary conscious memory.

Richardson-Klavehn and Gardiner (1996) found that by applying the PDP to derive the automatic and controlled estimates, cross-modality priming was entirely attributed to controlled voluntary processes. It is apparent that embedded within the PDP, there is the hidden assumption that consciousness is the same as retrieval volition. Instead, cross-modal priming could still be mediated by automatic, involuntary processes but still accompanied by an awareness of the study episode. By estimating automatic and controlled processes with the PDP, researchers are led to the erroneous conclusion that cross-modal priming is purely an expression of contamination by voluntary retrieval. Cross-modality, rather than being a product of voluntary contamination, can still be a form of involuntary priming mediated by modality independent abstract lexical representations that are automatically accessed during involuntary retrieval (e.g., Kirsner, Dunn, & Standen, 1989; Curran, Schacter, & Galluccio, 1999; Weldon, 1991).

Mecklenbrauker et al. (1996) used the PDP to separate controlled and automatic influences of memory in conceptual involuntary retrieval. A depth-of-processing effect was found on the involuntary retrieval of primed category exemplars. Estimates from the PDP showed an effects of depth of processing on conscious, but not on unconscious uses of memory. Following the same argument of cross-modal priming, the results obtained with the PDP could be taken to argue that depth-of-processing effects in conceptual incidental memory are an expression of a contamination from a voluntary retrieval strategy. Mecklenbrauker et al. (1996) subscribe to the Richardson-Klavehn and Gardiner (1996) view that the role of involuntary conscious retrieval is underestimated by the use of the PDP and that conceptual involuntary retrieval could still be mediated by automatic, involuntary processes that are accompanied by an awareness of the study episode. Conceptual priming can also be seen as a form of cross-modal priming which is mediated by modality independent abstract representations. The following study makes a preliminary attempt to measure the conscious correlates of conceptual incidental memory to test the extent to which conceptual priming is accompanied by conscious awareness.

6.2 Experiment 6.

In this experiment two-word phrases and semantic weak associates, matched for association strength, were studied with a phonemic and semantic study task. Modality of presentation was manipulated with half the pairs presented visually and the other half auditorily. Retrieval performance in an intentional (inclusion) test was compared performance in an incidental test. The experiment aimed to replicate the finding in the previous experiments (Experiment 5a,b) of a depth-of-processing effect on voluntary retrieval, regardless of association type, and on the involuntary retrieval of the weak associates but not on the involuntary retrieval of the two-word phrases. If priming of the two-word phrase was mediated by perceptual processes/systems then the lack of a depth-of-processing effect could be explained by the task being simply a special form of a perceptual incidental task. This state of affair would bring into question the dissociation between conceptual incidental and conceptual intentional test performance reported in the earlier experiments (Experiment 3,4,5a,b). It was reasoned that, if priming is mediated by a perceptual system/process, then a modality effect should be obtained for the two-word phrases. Instead, a modality effect is not expected in the inclusion and in the incidental tests for the weak associates. However, if priming of the two-word phrases is mediated by modality-independent, abstract, lexical representations, a modality effect was not predicted on the retrieval of these pairs either.

At the end of the test phase, all the word-association completions produced by participants were re-presented for the participants to indicate which pair they recognised as a studied pair. In the same way as in cross-modality priming, it was predicted that the incidental test of word association reflects involuntary, but conscious, memory. (An on-line recognition procedure would have allowed stronger inferences to be drawn on the state of awareness of the participant during the test. However, a post-test recognition test was adopted to allow participants who were given an incidental test to engage in a continuous task of free association with no interruptions comparable with the other experiments in this thesis.)

6.3 Method

6.3.1 Participants, Design and Materials

The participants were forty other students from City University and Westminster University who did not take part in any of the other experiments. The students were either paid for their participation or participated for partial fulfilment of course credits. The experiment was a 2x2x2x2 mixed factorial design, with test instructions (incidental vs. inclusion) as the between-participants variable. Depth of processing (phonemic vs. semantic), association type (two-word phrases vs. weak associates) and modality (visual vs. auditory) were the within-participant variables. Participants were randomly assigned to the two test conditions, with 20 participants in each of the two groups. Half of the participants (in each retrieval instructions group) did the phonemic study task first and the semantic task second; the other half did the semantic study task first, and the phonemic task second. For each study task, the order of the presentation modality was counterbalanced (see Design in Appendix 6.1).

The materials consisted of the same 120 word-pairs used in Experiment 5a and 5b (see Appendix 5.2 where all the material used is reported in a table). Sixty word-pairs were two-word phrases and sixty were weak associates (which did not constitute a phrase) matched on association strength. The 120 word-pairs were divided systematically into five lists of 24 word-pairs each with very similar association strength on average (see Appendix 6.2) at around 19%. Of these 24 word-pairs lists, 12 were two-word phrases and the other 12 were semantic associates with matched low-association strength. Each list was constructed so that the mean association strength was similar at around 19% for both types of association (see Appendix 6.2)

At study, the assigned word-pairs lists were presented in a fixed random order. Each participant saw in total four lists of 24 word-pairs, two lists were studied under each study tasks. Under the two study tasks, one list was presented in the visual modality and the other list was presented in the auditory modality (see Appendix 6.1). At test, all the 120 word-pairs were presented in a different random order for each participant. These included all the four studied lists plus one unstudied list of 24 word-pairs each. The five word-pairs lists (four studied and one unstudied) were rotated according to a 5x5 Latin square (see Appendix 6.1). Unlike the previous experiments, the unstudied words were, this time, only a fifth of the studied list. It could be argued that this smaller number of unstudied pairs would encourage the participants assigned to the involuntary retrieval group to engage in voluntary retrieval upon realising that they recognised *most* of the words, even if participants were informed of the studied status of some of the words as a matter of routine procedure. To ensure against this possibility, an additional 34 filler items (see Appendix 6.2) were introduced randomly in the test list of 120 items. So at test participants retrieved an associated words for a total of 154 words presented in a unique random order for each participants.

As in all the previous experiments an Apple Macintosh PowerBook (1400c) computer - programmed in the HyperCard environment - was used to present all the stimuli used in the experiment and to collect participants' responses.

6.3.2 Procedure

Each participant was tested individually. Participants were naïve to the purposes of the experiment and were only told that they would carry out a set of verbal tasks. In the study phase participants were seated in front of a portable computer and were shown the instructions on the computer screen. Participants were instructed that they would see two lists of word-pairs. They were told that they would either hear one half of the list and see the other half of the list (the instructions on the computer specified for each participant whether they would hear or see a list first according to the assigned format). For the visual presentation each word-pair appeared on the screen for 4 seconds, then the next pair was displayed on the screen after a half-second inter-stimulus interval. For the visual condition, the display of the pair on the screen was identical to that described in the procedure session of Experiment 6. For the auditory presentation, the two words were spoken by the computer with a new pair spoken every 4.5 seconds. Each word-pair was recorded digitally in the computer. On average, the duration of the spoken pair was about 1.5 seconds. The stimulus exposure duration was increased by an additional second in comparison to Experiments 5a and 5b to allow for the increased difficulty to respond quickly following the auditory presentation.

Participants were told that they would carry out two simple decisions in response to word-pairs that were going to be presented on the screen. Participants were given instructions about the two decision tasks in the order in which the participant was about to carry them out according to the counterbalancing order of the study conditions (see Appendix 6.1.) The wording of the orienting task instructions was the same as that of Experiment 5a and 5b. Participants were told that a set of instructions at the top of the screen will remind them which decision they would have to carry out for each word-pair list and which modality the word-pairs would be presented in.

During visual presentation, immediately below each word (directly in the middle of the word) there was a small empty circle on the screen as in the previous word association experiments. During the auditory presentation these circles still appeared in the same position as in the visual study condition and functioned in the same manner as in the visual presentation but the words above them did not appear, they were just spoken by the computer. To select the first word participants had to press the shift-key on the keyboard which was labelled "Word 1". To select the second word they were to press the apple-key labelled "Word 2". When the participant could not make a selection, as the words were the same in respect to the decision they had to carry out, then they were to press the "Word 1" and "Word 2" keys together. As participants made any of these response the circle corresponding to each respective word became darker to indicate their selection. Participants were instructed that they had to make their selection within the 4 seconds during which the word-pairs in the visual condition appeared and during which the selection circles in the auditory conditions appeared. If they were to miss one trial then they were just to concentrate on the next trial. Participants had no difficulty in making their selection within these time limits. Participants also had little difficulty comprehending the spoken presentation of word-pairs. To accustom participants to the auditory presentation and their answer format, an example of a trial was given for both modalities after participants read the initial instructions.

The same distractor task as in Experiment 5a and 5b was administered. The test procedure was identical to that of experiment 5a for the incidental test and 5b for the intentional-inclusive test. Twenty participants were presented with incidental test instructions and the other twenty were presented with inclusion test instructions adjusted from those used in the previous experiments to take into account the auditory presentation. The assignment to the two test conditions was randomly determined.

At the end of the test phase all participants were told that they would see all the word-pairs they produced at test. This time participants were to say whether they remembered coming across the pair they produced in the study phase (see Appendix 6.3 for the post-test instructions). Participants' associates responses at test were typed and were recorded by the computer. The cue word and the associated word produced at test by the participant was then re-presented to the participant in the same format as in the study phase. The participant had to press the "yes" button, with a mouse click, if they were positive that they saw or heard the word-pairs in the study phase. The participants were to press the "no" button if they did not think they saw or heard the word-pairs in the study phase. They were instructed to be conservative in their responses and to press the yes button only if they were very confident that the pair appeared at study.

6.4 Results

A response was considered a target response only if the studied words and the words produced at test were identical. Both plural and singular versions of studied words were considered target associations. Baseline association strength was calculated by the production of the selected word-pairs without the participant having studied the word-pair. The raw data for each participant and for each item is shown in Appendix 6.4 and 6.5

respectively. The mean proportions of target associations are reported in Table 6.1. For each condition the number of words recognised in the post recognition test i.e. the words that were consciously remembered are reported in brackets.

TABLE 6.1

MEAN PROPORTIONS AND STANDARD ERRORS OF WORD ASSOCIATES THAT CORRESPONDED TO TARGET WORDS (STUDIED AND UNSTUDIED) AS A FUNCTION OF TEST INSTRUCTIONS, DEPTH OF PROCESSING, ASSOCIATION TYPE AND MODALITY. THE NUMBER OF CONSCIOUSLY REMEMBERED WORDS FOR EACH CONDITION IS REPORTED IN BRACKETS.

		Studied				*Unstudied*	
	Association	*Phonemic*		*Semantic*		*(Baseline)*	
		Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*
		Incidental Test					
Visual modality	*Two-word phrases*	.47 (.20)	.03 (.04)	.48 (.47)	.04 (.04)	.19 (.01)	.02 (.01)
	Weak associates	.31 (.12)	.03 (.03)	.42 (.37)	.04 (.04)	.22 (.02)	.03 (.02)
		Inclusion Test					
	Two-word phrases	.48 (.24)	.04 (.04)	.78 (.69)	.03 (.05)	.22 (.01)	.03 (.01)
	Weak associates	.47 (.24)	.04 (.05)	.85 (.78)	.04 (.05)	.20 (.01)	.02 (.01)
		Incidental Test					
Auditory modality	*Two-word phrases*	.38 (.23)	.03(.04)	.42 (.31)	.04 (.03)	.19 (.01)	.02 (.01)
	Weak associates	.30 (.12)	.04 (.03)	.40 (.33)	.04 (.04)	.22 (.02)	.03 (.02)
		Inclusion Test					
	Two-word phrases	.43 (.25)	.03 (.04)	.70 (.60)	.03 (.05)	.22 (.01)	.03 (.01)
	Weak associates	.43 (.25)	.05 (.05)	.74 (.67)	.03 (.05)	.20 (.01)	.02 (.01)

The level of significance for all the following analyses was set at 0.05. As in the previous experiments, the baselines in the incidental test for the two-word phrases (M=19, SE=.01) and for the weak associates (M=.22, SE .02) did not differ significantly [$F_{(1,38)} = .08$, p =.785]. The baselines in the incidental test (M=.22, SE=.01) and inclusion test (M=.20, SE=.01) also did not differ significantly [$F_{(1,38)} = .03$, p =.861]. There was also no significant association by retrieval test interaction [$F_{(1,38)} = .68$, p =.414].

A second analysis was carried out to check if significant priming was obtained in all conditions in the incidental test. Priming was measured by subtracting the proportion of unstudied target words from the proportion of studied target words individually for each participant. The mean priming magnitudes are reported in Table 6.2.

TABLE 6.2

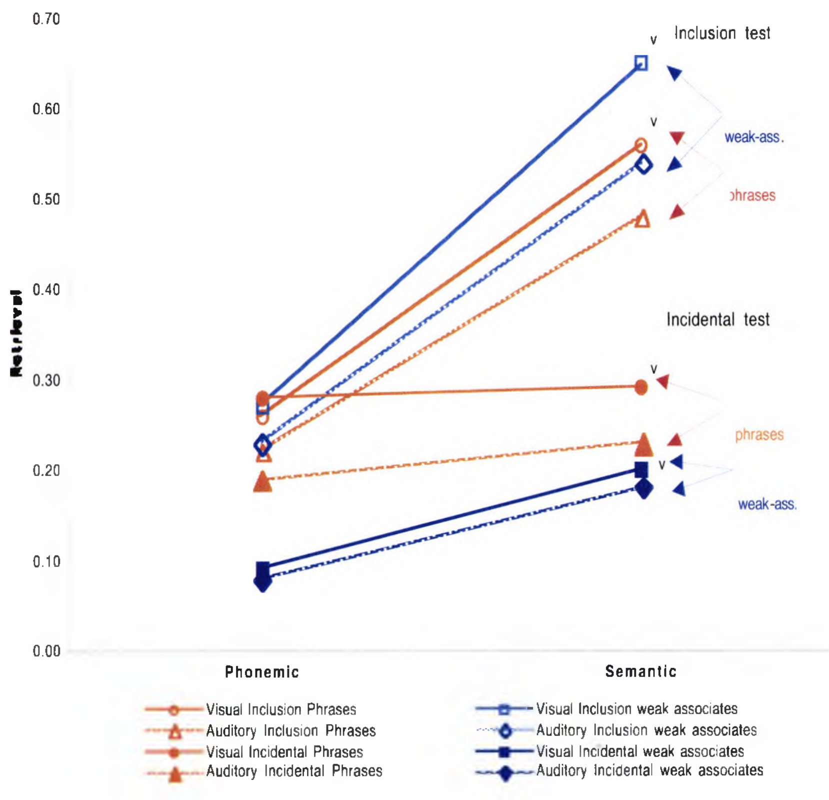
MEAN PROPORTIONS OF CONCEPTUAL PRIMING (UNSTUDIED BASELINE SUBTRACTED) IN THE INCIDENTAL TEST AND IN THE INCLUSION TEST AS A FUNCTION OF DEPTH OF PROCESSING, ASSOCIATION TYPE AND MODALITY.

		Phonemic	***Semantic***
Visual modality		**Incidental Test**	
	Two-words phrases	.28	.29
	Weak associates	.09	.20
		Inclusion Test	
	Two-words phrases	.26	.56
	Weak associates	.27	.65
Auditory modality		**Incidental Test**	
	Two-words phrases	.19	.23
	Weak associates	.08	.18
		Inclusion Test	
	Two-words phrases	.22	.48
	Weak associates	.23	.54

By comparing target production of unstudied items with studied items for each of the two depth-of-processing tasks, a significant priming effect was obtained following both the phonemic [visual: $F_{(1,19)} = 46.97$, $p < .001$; auditory: $F_{(1,19)} = 15.14$, $p = .001$], and semantic study task [visual: $F_{(1,19)} = 64.85$, $p < .001$; auditory: $F_{(1,19)} = 47.38$, $p < .001$].

An inspection of Figure. 6.1 where incidental and inclusion test data (corrected for baseline) are reported as a function of depth of processing, modality and association type, shows a striking dissociation between the inclusion and the incidental test with respect to depth of study processing. In the incidental test there is also an evident dissociation between the two-word phrases and the weak associates, where the involuntary retrieval of the two-word phrases is left unaffected by the depth-of-processing manipulation, whilst weak associates replicate the previous findings of being affected by this manipulation. The modality effect in this graph is difficult to discern without further statistical analyses. Analyses were carried out to confirm and further clarify these patterns.

FIGURE 6.1
INCIDENTAL AND INCLUSION TEST PERFORMANCE (BASELINE SUBTRACTED) AS A FUNCTION OF MODALITY, DEPTH OF STUDY PROCESSING, AND ASSOCIATION TYPE



A first analysis was carried out on corrected scores to check that the instruction manipulation yielded different performance patterns. A 2x2x2x2 mixed ANOVA with test instructions (inclusion vs. incidental) as the between participants variable and three within participants variables of depth of processing (semantic vs. phonemic), association type (two-word phrases vs. weak associates) and modality (visual vs. auditory) was carried out. The effect of the test instruction was significant [$F_{(1,38)} = 33.16$, $p<.001$] showing that the two retrieval tests yielded different retrieval performances. There was also an overall significant modality effect [$F_{(1,38)} = 12.58$, $p=.001$], a main depth-of-processing effect [$F_{(1,38)} = 27.32$, $p<.001$] and a significant main effect of association type [$F_{(1,38)} = 45.83$, $p<.001$]. (This analysis is reported in Appendix 6.6, where further details of interactions can be inspected.)

Data from incidental and inclusion tests were analysed separately to clarify individual effects. A 2x2x2 repeated measure ANOVA was carried out on the corrected scores from the 20 participants in the incidental test with depth of processing, associations type and modality as within participant variables. An overall modality effect was observed [$F_{(1,19)} = 4.98$, $p=.038$] as well as an overall depth-of-processing effect [$F_{(1,19)} = 9.57$, $p=.006$] and association type effect [$F_{(1,19)} = 10.21$, $p=.005$] indicating that two-word phrases were significantly better retrieved than weak associates. The only significant interaction was the important depth of processing by association interaction [$F_{(1,19)} = 5.33$, $p=.032$], which replicated the findings of the previous set of experiments of a different depth-of-processing effect on the different association types. Planned comparisons revealed that depth-of-processing effects were found for the involuntary retrieval of weak associates in the visual modality [$t_{(19)} = -2.50$, $p= .022$] and approaching significance in the auditory modality [$t_{(19)} = -1.87$, $p= .077$] but not for the two-word phrases [auditory: $t_{(19)} = -.70$, $p= .494$; visual: $t_{(19)} = -.40$, $p= .697$]. All other interactions were not significant. In particular, the modality by association interaction was not significant [$F_{(1,19)} = .04$, $p=.836$] indicating that modality effects were pervasive on both association types and were not just restricted to the two-word phrases. Furthermore, the three-way interaction of modality by association type by depth of processing was also not significant [$F_{(1,19)} =.12$, $p=.731$], suggesting that the dissociation in conceptual priming between the two-word phrases and the weak associates, in the extent that they are modulated by depth of study processing, is not related to modality, that is the cross-modal priming component of two-word phrases is also not affected by depth-of-processing effects.

In the intentional test, the same 2x2x2 repeated measures ANOVA on corrected scores revealed a significant main effect of modality [$F_{(1,19)} = 7.59$, $p=.013$], depth of processing [$F_{(1,19)} = 20.69$, $p<.001$] and association type [$F_{(1,19)} = 39.60$, $p<.001$]. The association effect was though now in the opposite direction than in the incidental test: this time weak associates were significantly better retrieved than two-word phrases. There was a significant modality by depth of processing interaction [$F_{(1,19)} = 35.03$, $p<.001$] showing that the depth-of-processing manipulation had a more marked effect on the pairs presented in the visual modality than in the auditory modality. There was also a significant modality by association interaction [$F_{(1,19)} = 78.57$, $p<.001$] showing that the advantage of visually processed words was more marked for the weak associates than for the two-word phrases. The crucial depth of processing and association type interaction was not significant [$F_{(1,19)} = 1.90$, $p=.184$] showing that both two-word phrases and weak associates show a similar depth of processing effect.

In terms of the consciousness data, the main analysis looked at the extent to which there was evidence for involuntary unconscious memory. The proportion of items that were recollected in the recognition test, were subtracted from the retrieval magnitudes in the incidental and inclusion test. These results are reported in the table below:

TABLE 6.3

MEAN PROPORTIONS OF RETRIEVAL UNACCOMPANIED BY CONSCIOUS AWARENESS OF THE PAIRS PRESENTED IN THE STUDY PHASE AND IN THE INCLUSION TEST AS A FUNCTION OF DEPTH OF PROCESSING, ASSOCIATION TYPE AND MODALITY.

		Studied		***Unstudied***
	Association type	**Phonemic**	**Semantic**	**(Baseline)**
Visual modality		**Incidental Test**		
	Two-words phrases	.27	.02	.18
	Weak associates	.19	.05	.20
		Inclusion Test		
	Two-words phrases	.24	.09	.21
	Weak associates	.23	.07	.19
Auditory modality		**Incidental Test**		
	Two-words phrases	.15	.11	.18
	Weak associates	.18	.07	.20
		Inclusion Test		
	Two-words phrases	.19	.10	.21
	Weak associates	.17	.07	.19

As it can readily be seen from the table, there is little evidence for non-conscious retrieval being above baseline in cross-modal priming as non-conscious retrieval of auditorily presented pairs is consistently below retrieval of unstudied words (baseline). This reinforces the findings of Richardson-Klavehn and Gardiner (1996) that cross-modal priming reflects retrieval which is conscious but still involuntary, as testified by the lack of a depth-of-processing effect for the two-word phrases in the incidental test and the presence of this effect in the inclusion test. In the visual condition however, following a phonemic study processing, non-conscious retrieval is numerically above baseline. Statistical analyses for the visually presented pairs were carried out to clarify these patterns. In the inclusion test there is no evidence that recalled pairs, which are unaccompanied by conscious recollection, statistically exceed baseline. A 2X2 repeated measure ANOVA with phonemic study status (phonemic studied vs. unstudied) associations type (two-word phrases vs. weak associates) as within participant variables, was carried out on the data from the inclusion test. A main effect of studied status [$F_{(1,19)}$= 1.45, p= .244] and association type [$F_{(1,19)}$= .32, p= .579] was not revealed. Also the interaction of association with study status was not significant [$F_{(1,19)}$= .01, p= .932]. In the incidental test, the same analysis yielded no overall effect of phonemic study orientation in promoting unconscious retrieval above baseline [$F_{(1,19)}$= 1.96, p= .178] or of association type [$F_{(1,19)}$= 1.08, p= .311]. However the interaction with association type was approaching significance [$F_{(1,19)}$= 3.34, p= .084], indicating that there was some evidence, although tenuous, of unconscious involuntary retrieval for the two-word phrases.

In general, from this preliminary data on the conscious correlate of conceptual involuntary memory, we can conclude that conceptual involuntary retrieval was accompanied by conscious awareness that the primed pairs were encountered in the study phase. This finding seems to apply to both types of association, despite the two types of association being different in their susceptibility to depth-of-processing effects.

6.5 Discussion

In this experiment, the previous important result of a dissociation between paired associates constituted by a two-word phrase and matched weak associates was replicated. In involuntary retrieval two-word phrases were found not to be susceptible to depth-of-processing effects. By contrast, involuntary retrieval of weak associates of matched association strength was found to be affected by elaborative study processing. Instead, both types of associations were found to be affected by the same depth-of-processing manipulation when retrieval was intentional. In this experiment the dissociation between the two types of associations is also extended to, and replicated in, cross-modal retrieval when associates are presented auditorily at study and retrieval is cued visually at test. Following auditory presentation, depth-of-processing effects on voluntary retrieval are found for both types of association. Instead, involuntary retrieval of auditorily presented two-word phrases was not susceptible to depth-of-processing effects, whilst auditorily presented weak associates were.

The priming observed with the two-word phrases cannot be attributed to a perceptual component, as modality effects were not restricted to this type of association. Modality effects were also found in the involuntary retrieval of the weak associates and in the intentional-inclusion test. In the intentional test, the modality effect replicates some earlier findings (Craik, Moscovitch, & McDowd 1994; Gathercole & Conway, 1988; Jacoby & Dallas, 1981; Richardson-Klavehn & Gardiner, 1996). The effect was found equally for both the weak associates and the two-word phrases.

The size of the modality effect in the incidental test did not statistically differ between the weak associates and the two-word phrases. A larger effect in involuntary retrieval for the two-word phrases rather than for the weak associates of the modality match over the modality mismatch could have indicated the reliance of the priming of the two-word phrases on a perceptual system/processes. But the interaction of modality with association type was not significant. However, an inspection of Figure 6.1 seems to indicate that the modality effect is more marked for the two-word phrases than for the weak associates, where the effect seems almost negligible. Statistically this conclusion is not granted and possibly low levels of priming in the weak associates might contribute to this smaller effect. However, the suggestion would be that perceptual system/processes are in operation for this two-word phrases. Nevertheless, what is striking about these results is that the cross-modal component for the two-word phrases is also not susceptible to depth-of-processing effects. So, it cannot be concluded that the reliance on a perceptual system/process for the involuntary retrieval of the two-word phrases (or, by extension, strongly related words) determines the absence of a depth-of-processing effect. The absence of a depth-of-processing effect on the cross-modal component, which relies on modality independent representations, further reinforces the hypothesis that an absence of elaborative study processing effects on the retrieval of two-word phrases, is a genuine property of conceptual, rather than perceptual, involuntary retrieval.

The above argument and the lack of a statistically larger modality effect for the two-word phrases grants the following broad conclusion. It can be asserted that the effects obtained for the strong associates and for the two-word phrases in conceptual priming is dependent on pre-existent, *modality- independent,* representations. It is the nature of the association between two words in a pair that determines whether involuntary retrieval is modulated by depth of encoding processing.

The parallel presence of depth-of-processing effects in conceptual priming and voluntary retrieval should not be interpreted as evidence that the two forms of retrieval tap the same process. Conceptual involuntary and voluntary retrieval are still distinct forms of retrieval supported by either different systems or different processes or different representations. In the same way, the presence of depth-of-processing effects in conceptual priming should then not be interpreted as a marker of contamination from a voluntary retrieval strategy.

In terms of the second, more exploratory, aim of the current study, it can be concluded that there is little evidence that conceptual incidental priming, like cross-modal priming, is associated with involuntary non-conscious memory. Instead, the evidence points towards the claim that conceptual priming reflects involuntary, as testified by the satisfaction of the retrieval intentionality criterion, but conscious processes.

Chapter 7

Conclusion

Overview of Chapter 7

Depth of processing has been a dissociating variable of paramount importance in the study of memory and its relation to consciousness. In this series of studies, the effects of depth-of-processing manipulations on the familiarity component of recognition memory and on conceptual priming were explored to greater extent. Toth (1996) suggested a conceptual connection between measures of familiarity and measures of conceptual priming as he uncovered evidence that familiarity measures, in the same way as conceptual priming, are affected by conceptual manipulations. The first two experiments of the thesis investigated depth-of-processing effects on subjective measures of familiarity. Contrary to Toth's (1996) findings, familiarity indexed by Know responses was found not to be susceptible to depth-of-processing effects. The investigation proceeded by looking at depth-of-processing effects on conceptual priming, as a limited amount of evidence suggested that the presence of a depth-of-processing effect was not a universal phenomenon (e.g., Vaidya et al.,1997). This absence of a depth-of-processing effect would have substantial implications for the dissociation of conceptual priming from performance in intentional tests and for the importance of the voluntary/involuntary dichotomy. In six different conditions (across Experiments 3 to 6) a dissociation was replicated between voluntary and involuntary retrieval of word-pairs with a corresponding more stable representation following a manipulation of depth of processing at study. This manipulation had an effect on the voluntary retrieval of the pairs but not on the involuntary retrieval of such pairs. The dissociation found between the intentional and incidental tests for strongly associated words (Experiment 3) was replicated in older adults (Experiment 4) and was not an artefact of ceiling effects as compound word-pairs with low association-strength baseline (Experiment 5 a,b) did not show an effect of depth of processing either. Finally, a further study (Experiment 6) was carried out to investigate whether the lack of an effect of depth of processing on involuntary retrieval of word-pairs with a more stable representation was related to the retrieval processes being perceptual in nature, making it a special case of perceptual involuntary retrieval. The lack of a specific modality effect in this form of retrieval places this conjecture on tenuous ground and supports the hypothesis that involuntary retrieval of words pairs with a stable association is based on more conceptual processes.

A depth of processing variable has an effect on the voluntary measure of memory but not on the incidental measure of memory for word-pairs with a compound association; in this manner the retrieval intentionality criterion is satisfied. The overall results make two major related points. Firstly this dissociation goes some way to support the idea that involuntary/voluntary dichotomy in memory still has important explanatory power. And, dissociations between performances in incidental and intentional tests are not explained by the selective recruitment of data-driven or conceptually driven processes guided by test demands as dissociations are obtained between conceptual tests. Secondly, this dissociation, which continues to persist when response bias between tests is equated (Experiment 5 and 6), speaks against the hypothesis that incidental conceptual tests are contaminated by voluntary retrieval strategies.

7.1 Consciousness and Memory

Depth-of-processing manipulations have played a critical role in the study of the retrieval of a mnemonic representation with or without volition or conscious awareness of the encoding episode. Voluntary retrieval greatly benefits from processing which focuses on the semantic structure of the material to be retrieved. This benefit can be measured with voluntary retrieval following a depth-of-processing manipulation and by Remember responses in a recognition test. By contrast, it seems that involuntary retrieval or responses based on familiarity (as indexed by Know responses) in a recognition test are left generally unaffected by manipulations of depth of processing at encoding.

This kind of dissociation related to the depth-of-processing variable has expanded our understanding of memory and has attracted several explanations. As reviewed in chapter 1, theorists from a more neuropsychological background saw these dissociations as further evidence for the existence of separate systems sub-serving different forms of retrieval. A theoretically important distinction was drawn between memory retrieval with conscious awareness of the encoding episode, and memory retrieval without conscious awareness. The original assumption embedded within this approach was that separate memory records were being accessed when the two retrieval modes were engaged and a non-unitary view of memory was advocated. Various hypotheses were formed about the brain structures responsible for laying down memory representations in reference to the voluntary/involuntary distinction.

The proposal that differences in retrieval volition (as supported by separate brain/mind systems) explained dissociations of memory performances had often been questioned (Blaxton, 1989; 1992; Brunfaut & Dydewalle, 1996; Roediger, 1990). As seen in Chapter 1, other theorists, coming from a more cognitive tradition, had a more parsimonious view of memory representations. Such advocates generally tended to subscribe to a unitary view of memory and argued that memory tapped by intentional memory tests shared common representations as memory tapped by incidental tests. They argued that dissociations were obtained because of the operations of different processes, rather than systems, in different tests. This view has been originally seen as undermining the critical role of the involuntary/voluntary dichotomy in memory retrieval. The orthogonal conceptual/perceptual processes dichotomy was proposed as the critical distinction that accounts more adequately for the observed dissociations in performance between incidental and intentional tests. Depth-of-processing manipulations would have an effect only when conceptual processes at retrieval are involved. As voluntary and conceptual involuntary retrieval calls upon these processes and perceptual involuntary retrieval calls mainly upon perceptual processes, depth-of-processing effects are only found in voluntary retrieval and conceptual involuntary retrieval, and not in perceptual involuntary retrieval.

In this thesis the relative importance of the two proposed distinctions was considered further in relation to the types of representation involved in the memory tasks. By focusing on the type of representations involved in conceptual tasks it was possible to elucidate some conflicting results reported in the literature that have been used to support either a systems or a processing view.

As reported in Chapter 1, depth-of-processing effects on memory have also been of paramount importance in a related controversy on the relationship between voluntary and involuntary memory. Since the first dissociations between intentional and incidental tests were reported, depth-of-processing effects were used as a marker of the operation of a voluntary retrieval strategy, and an absence of these effects in incidental tests was taken as a marker of the operation of an involuntary retrieval strategy. Therefore, when depth-of-processing effects were reported on retrieval performance in seemingly incidental tests, these effects have been interpreted as evidence of contamination of the incidental test by a voluntary retrieval strategy (Reingold & Toth, 1996; Toth & Reingold, 1996; Toth, Reingold & Jacoby, 1994). Further problems arise with this conjecture and conceptual memory. Performance in conceptual incidental tests in most respects behaves like voluntary retrieval and seems to be affected by manipulations of depth of processing at study which, from this perspective, imply contamination. In this thesis a study of depth-of-processing effects on conceptual incidental tests allowed further assessment of the merits of this hypothesis.

7.2 Overview of the Experimental Results and their Theoretical Implications

7.2.1 Depth of Processing and Familiarity (Experiments 1 and 2)

In Chapter 2, the link between the familiarity component of recognition memory and conceptual priming, as proposed by Toth (1996), was explored. The two experiments examined the effect of depth of processing on the familiarity component. Originally, the phenomenon of familiarity, which was believed to be perceptually based, was compared to perceptual priming. Jacoby & Dallas (1981) amongst others hypothesised that the two expressions of memory may share the same components or representations. However, recently findings have been reported that showed perceptual effects on recollective processes (e.g., Dewhurst & Conway, 1994, Rajaram, 1996) and conceptual effects on familiarity based processes (Mantyla, 1997; Toth, 1996; Wagner, et al., 1997). Some authors such as Toth (1996) have hence proposed that familiarity can be affected by conceptual manipulations in the same way that conceptual priming is. Toth (1996) demonstrated a depth-of-processing effect on the component of familiarity by adopting the technique of speeded recognition to separate the familiarity and recollection component. This finding contradicted the previous reports of a lack of conceptual effects on measures of familiarity as indexed by Know responses (e.g., Gardiner, Java, & Richardson-Klavehn, 1996).

The effects of conceptual encoding processing on familiarity were investigated in this thesis by combining measures from the speeded recognition experimental paradigm with Remember and Know measures. In two experiments it was found that familiarity, as measured by Know responses, did not show conceptual manipulations effects, even when participants were allowed very little time to make the recognition response. In the first experiment depth of processing was manipulated at study, and in the second experiment a *generate* study condition for which there was no perceptual overlap at test, also produced no advantage for familiarity over words just *read.*

It was proposed that the discrepancy between the present findings and Toth's (1996) earlier results is explained by the inability of the speeded recognition procedure to sufficiently capture the familiarity and recollection components as measured by the Remember and Know procedure. In the speeded recognition procedure recognition responses obtained at the short delay (where in this case participants were forced to give a response within 500 ms.), were compared with responses obtained at the longer delay (where participants report their responses after 1500 ms.). According to the measures obtained in the two experiments reported in this thesis, it was found that, at the short deadline, a large number of recognition responses were still accompanied by recollection. Conceptual manipulations effects were to be attributed to fast-acting recollection (as measured by Remember responses) rather than to a fast acting familiarity (as measured by Know responses). When Remember and Know judgements were applied to recognition responses carried out within a short delay, it was found that quite a large proportion of the responses was still accompanied by recollection of the study event. By contrast, the familiarity component, as measured by Know responses, showed no effect of conceptual manipulation.

If Know responses are accepted as an index of familiarity, the experiments provide evidence against the effects of conceptual manipulations on familiarity based responses. The lack of effect of conceptual manipulation on the measure of familiarity is not though taken to logically imply that the link between familiarity and conceptual priming is to be rejected, as conceptual effects on conceptual priming measures are not consistently reported. The rest of the experiments in the thesis further investigated the relation between conceptual manipulations and involuntary conceptual memory.

7.2.2 Depth of Processing and Association Strength in Conceptual Involuntary Memory (Experiment 3)

A review of the literature relating to conceptual priming revealed increasing evidence for the dissociation between conceptual involuntary memory and voluntary memory, even if they both are modulated by manipulations of conceptual processing at study. Nevertheless, the lack of a dissociation between voluntary and conceptual involuntary retrieval related to depth-of-processing manipulations, constantly threw doubt over the usefulness of the voluntary/involuntary dichotomy in memory. In Experiment 3 (reported in Chapter 3), the aim was to further elucidate the nature of effects of depth of processing on conceptual priming. The effects of four tasks that modulated depth of processing at study were analysed in relation to voluntary and involuntary conceptual retrieval.

As reviewed in Chapter 1, only a minority of conceptual priming studies (e.g. Shacter & McGlynn, 1989; Vaidya et al., 1997) failed to obtain depth-of-processing effects in conceptual incidental tasks. From these studies there was the suggestion that depth-of-processing effects in incidental tests of word association were negligible as compared to those in an intentional test when pairs with strong associations were primed. In Experiment 3, associative strength between words was varied systematically in order to carry out a finer grain analysis of the interaction of depth-of-processing effects with association strength effects. A continuous range of word association strengths was adopted which enabled better identification of optimal levels of association strength for observing differences in depth-of-processing effects.

The results of this experiment showed that only strongly related words were not susceptible to a depth-of-processing effect when their retrieval was involuntary. A depth-of-processing effect was found for involuntarily retrieved word-pairs which had a weaker association strength. In voluntary retrieval, a normal depth-of-processing effect was obtained for all the pairs regardless of their association strength.

Further evidence of the dissociation between conceptual involuntary memory and voluntary memory was provided by this study. Two dissociations were obtained, one between performances in the incidental and intentional tests for the strongly associated words and one between the priming of strong and weak associates in the incidental test. These dissociations support the explanatory value of the involuntary/voluntary dichotomy in the study of memory. The difference between performances in the intentional and incidental tests are to be explained as the result of the two different strategies employed in solving the test mediated by different systems, or processes or components.

Furthermore, as a difference between the intentional and incidental test was reported, the depth-of-processing effect in the incidental test for the weakly associated pairs cannot be attributed to the contamination of the incidental test by a voluntary retrieval strategy. An explanation for this effect in the weakly associated words and not in the strongly associated words is to be found in some other factor that equally affects both forms of memory when words are not strongly associated.

An explanation for this finding was developed in Chapter 3. It was proposed that the degree of elaborative processing at study determines whether an association between words can be formed and retained. An already established association, or a word, has a pre-existing, stable representation; by contrast, a new association between semantically less well-related words does not have a pre-existing, stable representation. Once the word association is established and a compound representation is created, the representation can be voluntarily or involuntarily accessed and retrieved. It follows that in conceptual incidental tests where unfamiliar word-pairs are used, elaborative study processing is necessary to establish an association between two weakly related words in the pair. As a consequence, the learning of this association is revealed in involuntary retrieval. However, in the case of the presentation of word-pairs with a more established representation, no learning is required and conceptual priming is not modulated by the type of study processing.

This line of reasoning implies that depth-of-processing effects in voluntary and involuntary retrieval would have different causes. The advantage that is conferred by depth-of-processing effects in voluntary retrieval of word-pairs is to be understood as the result of the strengthening of the connection between the word-pair and the spatial/temporal co-ordinates in which they are presented. Elaborative processing at study confers an advantage over shallow processing in establishing this link between the context and the word-pair. This advantage is expressed by higher levels of voluntary retrieval when participants are asked to specifically remember word-pairs presented in the particular context of the study phase. Therefore, when established associations are used, a depth-of-processing effect should be found in an intentional task where contextual information is required, but not in the incidental conceptual task.

7.2.3 Conceptual priming and Ageing (Experiment 4)

The dissociation between performances in the intentional and incidental test of word association was examined further by extending the study to a population of older adults. Older adults have been consistently found to show marked voluntary memory deficits, linked particularly to impairment in remembering and not knowing (Parkin & Walter, 1992, Java, 1996, Perfect & Dasgupta). Ageing had always been an important dissociating variable between perceptual involuntary memory and voluntary memory. Older adults usually show similar perceptual priming to younger adults, despite being outperformed in intentional tests. Instead, in conceptual incidental tests, an impairment in older adults has been reported in a number of studies (Jelicic et al., 1996; Grober et al., 1992; Jelicic, 1995; Rybash, 1996). The link between impairment following voluntary and conceptual priming in older adults has been taken to support the more unitary view of memory proposed by "process" theorists. From the processing perspective it is argued that older adults have less efficient conceptually driven processes and normal perceptually driven processes. The deficiency in conceptually driven processes is expressed in poorer performance in intentional test and conceptual incidental tests, whereas perceptual tests are unaffected. However, there are also a number of reports that have shown that older adults perform equally well as young participants in conceptual incidental tests (Isingrini et al. 1995; Java, 1996; Light & Albertson, 1989; Monti et al., 1996). Experiment 4 (reported in Chapter 4) further examined the possibility that the discrepant results obtained with older adults are related to the type of representation formed at study.

It was hypothesised that older adults had less efficient conceptually driven processes but were just as efficient as young participants in conceptual involuntary retrieval. It was reasoned that conceptual priming for stable representations, as those corresponding with the association of strongly related words, would be equal in young and older adults. Instead, priming that required elaborative processing to be expressed, as with less familiar associations between words, would show an effect of age, because older adults have more difficulty in establishing an unfamiliar association. In this experiment only two levels of associations were compared (strongly and weakly associated words) as the previous experiment enabled the identification of optimal levels of association strength for obtaining a dissociation with a depth-of-processing manipulation.

As in Experiment 3, a dissociation between the incidental and intentional tests was found for the strongly related word-pairs, where a depth-of-processing effect was not observed in the incidental test but was observed in the intentional test. For the weakly related word-pairs a depth-of-processing effect was observed in both the intentional and incidental test. More importantly, older adults were significantly outperformed in the intentional test by the younger participants. In the incidental test no difference between age groups was reported for the strongly related words. Instead, for the weakly related words, older adults had more difficulty in retrieving the association following elaborative study processing.

The finding was interpreted to suggest that older adults were impaired in their use of elaborative processes at study. In the incidental test, where elaborative processes facilitate the binding of the constituent words to form a compound representation, the encoding impairment resulted in lower conceptual priming for the weakly associated words and equal priming for the strongly associated words. In the intentional test, where elaborative processes facilitate the binding of the word-pair to its spatial and temporal context, the older adults' impairment resulted in lower retrieval performance for all the pairs regardless of association strength.

7.2.4 Compound Representations (Experiment 5)

The results from Experiments 3 and 4 provided strong evidence that voluntary retrieval and conceptual priming can be dissociated. Nevertheless, conceptual elaboration at study can have an effect on both forms of retrieval. It was advanced that in involuntary retrieval, conceptual elaboration has the function of facilitating the binding of a representation incorporating both words. In the case of weakly associated words, where the association is less familiar, the corresponding representation would be a less established one. Instead, in the case of strongly associated words, the representation is probably already formed, as testified by the frequency of such reports in free association norms. If a representation can be established, or it is already in place, then conceptual manipulations do not have an effect on involuntary retrieval but they do on voluntary retrieval as a different process is involved. In Experiment 5, the nature of the representations that in conceptual priming are unaffected by depth of study processing, was investigated further. It was speculated that frequently co-occurring words in written and spoken language which form a two-word phrase (e.g., *coat-hanger*) constituted a compound representation. Two-word phrases were compared with word-pairs that did not constitute a phrase matched on association strength. In this way, the type of association (compound vs. weak) of the pair was manipulated, whilst baseline association strength was kept constant. This design permitted priming to be observed in the absence of baselines differences as in the strongly and weakly associated word-pairs comparisons of the earlier experiments.

Furthermore, in Experiment 5b, response bias (or baseline) in the intentional test was equated to that of the incidental test by introducing an inclusion test. The inclusion test prescribed that participants generate the first associate that came to mind should they fail to recall the studied associate. In this manner, depth-of-processing effects in the inclusion test not verified in the incidental test would have to be attributed to the different instructions to the incidental test, rather than to any difference in response bias (or baseline) between the tests.

As predicted, it was found that the involuntary retrieval of word-pairs with compound associations was also not affected by conceptual elaboration at study in the same way as strongly associated words. By contrast, the voluntary retrieval of compound pairs was affected by variation of depth of processing at study.

The extension of these results to a new set of material increases theoretical understanding of the processes involved in conceptual priming. In conceptual involuntary retrieval, if the type of representation that is primed is an established, pre-existent one, conceptual elaboration of the material at study is not necessary to obtain maximum priming levels. If the representation is yet to be established, elaborative processing confers an advantage to this consolidation process, and the advantage is expressed by higher levels of priming following more elaborate study processing. Depth-of-processing effects with less familiar word-pairs are explained by the building of a representation of the association between two weakly related words. This is different from the advantage that elaborative processing confers in voluntary retrieval. As can be seen from the results of Experiments 4, 5a and 5b, voluntary retrieval for both strong associates and compound word-pairs is still very much affected by manipulations of depth of processing. As suggested above this can be explained by the formation of a representation that binds the word-pairs to the spatial/temporal context in which it was learned.

One last remark about Experiment 5a and 5b is that the use of compound word-pairs with low association strength enabled to make the very important following assessment. It was possible to infer that the lack of depth-of-processing effects on the retrieval of strong associates in involuntary retrieval in the previous experiments was probably not an artefact of ceiling effects. It was probably a genuine null effect related to the nature of strong associates and their underlying representations.

7.2.5 Conceptual Priming and Modality (Experiment 6)

The last experiment in this series tested the hypothesis that the form of priming of two-word phrases or strongly associated word-pairs was mediated by the operation of perceptual processes and would simply be a special form of perceptual involuntary memory. Priming of word association in principle can be either structural, where a perceptual contiguity is relevant, or semantic, where conceptual relatedness is relevant. Strong associates partially, but compound words in particular, co-occur in written and in spoken language forming a perceptual gestalt. It was hypothesised that reconstruction of the pair at test could be mediated by a perceptual process rather than a conceptual one, in particular for strongly associated or compound word-pairs. The reliance of the priming of these word-pairs on perceptual processes would explain the dissociation obtained between the weakly associated words and the compound words in involuntary retrieval, as well as the dissociation obtained between involuntary and voluntary retrieval of the strong associates. If priming in the word association task for the strong and compound associates relies on perceptual processes, the dissociation between voluntary and involuntary conceptual retrieval is put on much less firm footing.

A modality manipulation was employed to detect the operations of perceptual processes. A modality effect is usually reported in perceptual priming but not in conceptual priming (Blaxton, 1989; Srinivas & Roediger, 1990; Carlesimo, 1994; Vaidya et al., 1995, 1997; Challis et al., 1993) attesting to conceptual priming being a separate process from perceptual priming. If the priming of compound associates is mediated by perceptual processes the retrieval of those associates would be affected by a modality manipulation and this would explain the lack of depth-of-processing effects.

In Experiment 6, a modality effect on voluntary and involuntary retrieval was obtained. The modality effect in the intentional test was of equal magnitude in both strong and weak associates. In the incidental test there was a slight suggestion that a stronger, but not statistically significant, effect of a modality was present for the two-word phrases than for the weakly associated word-pairs. This effect indicated that the difference between within modal priming and cross-modal priming was larger for the two-word phrases than for the weak associates. Such effect, which is though not significant, would support the hypothesis that, priming of two-word phrases is mediated by perceptual process. However, it would then be very surprising that in the cross-modal component of two-word phrases, which cannot be mediated by perceptual processes, a depth-of-processing effect is also not found.

The lack of a depth-of-processing effect in the cross-modal condition cannot be explained by perceptual factors coming into play.

The lack of a larger, statistically significant, modality effect for the compound associates permits the following broad conclusion. It can be asserted that the effects obtained for the strong associates and the two-word phrases in involuntary conceptual priming is dependent on established, modality-independent, representations. It is the nature of the association that determines the lack of depth-of-processing effects in involuntary retrieval of compound word-pairs.

The second aim of this study was more exploratory. It aimed to observe the extent to which conceptual involuntary retrieval was accompanied by awareness of the retrieved material being presented at study. Little evidence was obtained that, above baseline, conceptual involuntary retrieval is not accompanied by awareness of the study episode. However, due to the dissociation from involuntary retrieval, it is argued that conceptual priming is still involuntary: In the same way as argued for cross-modal priming in word-stem completion (Richardson-Klavehn & Gardiner, 1996), conceptual priming seems to reflect involuntary memory, but accompanied by conscious awareness of having a recent encounter with the retrieved material.

7.3 General Overview of the Theoretical Implications of the Results

7.3.1 Systems vs. Processes

The dissociations between incidental and intentional tests obtained in this series of experiments still support the role of the voluntary/involuntary distinction over the role of perceptual/conceptual processes distinction in informing theories of memory. As the former distinction is championed by theorists with a systems orientation and the latter by theorists with a processing orientation, the results could be taken as supporting the claims of systems theorists. However, these claims are only supported by the current results in as far as the voluntary/involuntary distinction is of value to theoretical accounts of memory. Whether there are systems or processes or a combination of the two in carrying out these functions is an unanswered question in this thesis. The question does though not seem so relevant as processes or systems can be postulated that could carry out both data-driven or conceptually driven functions or voluntary or involuntary functions. In this respect the tenets of the component-of-processing view (Moscovitch, 1989, 1992, 1994; Moscovitch & Umilta, 1990, 1991) are here embraced: task performance is governed not only by one component's internal operation but also by a network of connections to other components, which together form a functional unit or system.

The question is more in terms of which kinds of system fractionation (either the system described by the involuntary/voluntary dichotomy, or the one described by the perceptual/conceptual dichotomy) is the one with higher explanatory power. The current results support the fractionation proposed by systems theorists as having a stronger explanatory power. Processing theorists do not take the important position on the relationship between memory retrieval and phenomenological states of awareness. Although the conceptual/perceptual distinction is very valuable in accounting for some findings (e.g., Blaxton, 1989) the important and insightful distinctions on volition and consciousness may be under-emphasised in this approach.

The voluntary/involuntary distinction emphasises the role of consciousness and its importance in memory. The aim should be to understand this memory correlate and its role in memory function. In this thesis the value of the voluntary/involuntary distinction is supported but a further important distinction between conscious awareness and volition is emphasised. Little evidence is provided for conceptual involuntary retrieval being unconscious, but stronger evidence is provided to show that voluntary and involuntary processes can be dissociated.

The processing view can be seen as constraining the systems view by emphasising the connections between systems and suggesting alternative processing distinctions. The most profitable way forward for retaining a systems idea in memory is to investigate the specific processing contribution of the various brain areas, without making assumptions on the location of representations and the isolated recruitment of the processing in such area by only one mental operation. The way to address the problem it is to gain a detailed understanding of the specific processes that underlie memory for different kinds of information.

7.3.2 Memory Representations in Incidental and Intentional Tests

Tulving (1999) argued that the system/process debate is between believers in a unitary memory system with single representation that mediates all memory phenomena and believers in multiple memory systems with various distributed representations that are independently summoned by task demands. In relation to the unitary memory versus non-unitary memory debate, the obtained dissociations between voluntary and involuntary retrieval are not necessarily explained by the existence of different representations.

In this thesis the proposal put forward by Bower (1996, reviewed in Chapter 1) is found useful as a way of interpreting the dissociations between the incidental and intentional tests obtained with word-pairs with a more established association and not for word-pairs of a relatively less familiar association. Bower (1996) proposed that the difference between involuntary and voluntary retrieval is to be accounted by the different tests' demands. Conceptual incidental tests require the binding between the two words in the pair, instead intentional tests require the binding between the pair and its temporal/spatial context.

Within this framework, a suggestion is here made that elaborate processing at encoding promotes the binding between words in the pairs and between the pair and its spatial/temporal context. In this manner the obtained results can be easily explained. In the involuntary retrieval of word-pairs that have a pre-existing representation, elaborative study processing confers no advantage. By contrast, in voluntary retrieval, elaborative study processing confers an advantage to the retrieval of such pairs, as the association between the pair and its spatial/temporal context modulates retrieval performance.

Within this framework, the representation of the word-pairs tapped by voluntary and involuntary retrieval can logically partially overlap. But in voluntary retrieval, in addition the spatial/temporal context has to be bound to the representation in some form. In this way the dissociations can be accounted for by a unitary view of memory as the postulation of a separate representations is not necessary. However, the additional representation of the spatial/temporal context possibly kept separate from the representation of the word-pair may grant a distributed memory representation perspective.

One last point should be made about Bower's (1996) theory on the relationship between memory and consciousness. The theory is not explicit on the role of the conscious correlate of intentional and incidental memory tests. Within this theory there is no reason why, in principle, a certain form of retrieval should or should not be accompanied by conscious awareness.

7.3.3 Contamination Hypothesis and Involuntary Conscious Memory

Depth-of-processing effects in incidental tests can be interpreted (see, Jacoby et al. 1993) as a marker of the operation of a voluntary retrieval strategy, and a presence of these effects in incidental tests are interpreted as contamination of a voluntary retrieval strategy. Conceptual priming has been found to be modulated by manipulations of depth of processing at study in most experiments. These effects can be interpreted as contamination by voluntary retrieval (see Mecklenbrauker et al., 1996).

As a result of this conjecture of contamination between tests, experimental techniques have been developed to separate conscious and unconscious influences on retrieval. Jacoby (1991) and his colleagues developed the PDP (see Chapter 1) which was designed to put voluntary and involuntary retrieval in opposition. As reviewed in Chapter 1, this technique has been used extensively as a means of separating the respective contribution of automatic and controlled processes in memory tasks. This method is chosen in preference to the retrieval intentionality criteria (Schacter et al., 1989) for making inferences about memory processes as it deals with response bias. However, there are several limitations to the technique in the way it equates involuntary memory with unconscious memory. Richardson-Klavehn and Gardiner (1995 and 1996) have pointed out that involuntary memory can be both conscious and unconscious. In a word association task, the associated words could spring to mind involuntarily and the participant eventually realises and is conscious that the word appeared in the study phase. The production of the word is still involuntary and does not involve controlled retrieval. In this view, the PDP underestimates the extent of involuntary retrieval, because it confuses involuntary retrieval with unconscious retrieval. The automatic estimate includes only involuntary retrieval unaccompanied by conscious awareness and not involuntary retrieval accompanied by conscious awareness, which is paired with controlled processes. This would lead to erroneous estimates of the processes involved in involuntary and voluntary retrieval.

In the series of studies presented in this thesis, by reporting an absence of depth of processing in incidental conceptual task, it was demonstrated that conceptual incidental tests are not contaminated by a voluntary retrieval strategies. Across several experiments it was shown that in the same involuntary retrieval task, a dissociation was obtained with word-pairs with a compound association and pairs with a less familiar association. The former pair type exhibited no depth-of-processing effects, whilst the latter did, in the same involuntary retrieval task. As the association types were presented randomly in the test phase, it is difficult to argue that participants shifted between a controlled and an automatic strategy for, respectively, the less familiar and the more established word-pairs. However, this would be the underlying assumption within the process dissociation framework, as depth-of-processing effects signal contamination from controlled processes.

This thesis probes further the relationship between conceptual involuntary retrieval and conscious awareness. It was reasoned that as cross-modality priming relies on modality independent representations, similarities would be found with conceptual involuntary retrieval. Following the results from on line measures of conscious awareness (Richardson-Klavehn & Gardiner, 1996) in cross-modality priming, it was proposed that involuntary conceptual memory was indeed involuntary but possibly always accompanied by conscious awareness. By equating conscious awareness with retrieval volition, the PDP undermines the role of conceptual involuntary retrieval in memory as a separate phenomenon from that described by controlled processes.

This latter finding on conceptual priming being involuntary but conscious takes us full circle to the earlier experiments that looked at depth-of-processing effects on familiarity. In this thesis, it may tentatively be advanced that a link between familiarity and conceptual priming can still be entertained. In Experiments 1 and 2 it was verified how familiarity, as measured by Know responses, is relatively unaffected by depth-of-processing manipulations. In Experiments 3,4,5, and 6 strong evidence has been provided that word-pairs with a pre-established representation are also relatively unaffected by manipulations of depth of processing . If the idea of a connection between conceptual priming and familiarity is to be retained, it could be advanced that the same explanations in conceptual priming may apply in recognition memory. What determines a depth-of-processing effect in Remember responses is the formation of a link between the context and the word presented in the study phase. More elaborate study processing confers an advantage to the formation of the link between the words and the context in which they are studied. Therefore, words studied in this manner are more likely to be ascribed a Remember judgement than words studied with shallower study processing. By contrast Know responses are reported when a feeling of familiarity that a word has been encountered earlier occurs in the absence of conscious recollection of the context. These responses are not affected by variation in elaboration at study as a link between the context and the word is not established at study in the same way that in conceptual involuntary retrieval this link is not required. Also conceptual priming of associations with stable representations is not affected by elaborative study processing. Given the preliminary evidence that conceptual priming reflects involuntary memory accompanied by conscious awareness of a recent encounter, the connections with processes tapped by familiarity based responses may be revived. This could be the subject of further empirical enquiry.

7.4 Conclusion

In conclusion it can be said that the overall results make three major, related points. Firstly, the dissociations obtained go some way to support the idea that the involuntary/voluntary dichotomy in memory has still important explanatory power. In this way, the results favour the emphasis that systems theorists place on the voluntary/involuntary distinction. Secondly, depth-of-processing effects in an incidental and intentional word association test are the consequence of distinct phenomena. Depth-of-processing effects are obtained in conceptual priming only when the representations of the word-pair needs to be formed and are not obtained for compound word-pairs with an established representation. Depth-of-processing effects in intentional tests are reported for both pairs as elaborative processing promotes the binding of the word-pairs to their temporal/spatial context. Thirdly, the results speak against the hypothesis that incidental measures are contaminated by voluntary retrieval processes because the retrieval intentionality criterion can be satisfied in conceptual tests. The depth of processing variable has an effect on the intentional measure of memory but not on the incidental measures of memory with word-pairs with an established representation.

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Appendix to Chapter 2

Appendix 2.1 Word Lists from Experiment 1: List A and List B

LIST A				LIST B			
1	FIGURE	25	WEATHER	1	SUPPER	25	OPINION
2	INCOME	26	HAMMER	2	TITLE	26	REASON
3	THEORY	27	REPLY	3	HONOUR	27	COUNTRY
4	ELBOW	28	COURAGE	4	NATURE	28	PERFUME
5	SORROW	29	UNION	5	OCEAN	29	FARMER
6	INSTINCT	30	QUARREL	6	ACTION	30	LEADER
7	LAWYER	31	TRAFFIC	7	LION	31	REMARK
8	TUNNEL	32	GESTURE	8	SILENCE	32	IRON
9	CRITIC	33	CULTURE	9	FOREST	33	WITNESS
10	CASTLE	34	SADDLE	10	POWER	34	MINUTE
11	SCIENCE	35	MIXTURE	11	CENTRE	35	PROJECT
12	DEBATE	36	ARROW	12	STATION	36	LEMON
13	JUNIOR	37	COMMERCE	13	NEEDLE	37	EXHAUST
14	CRYSTAL	38	ORCHARD	14	FINGER	38	WHISPER
15	FEATHER	39	JEWEL	15	POCKET	39	CONTRACT
16	ANGEL	40	PROGRAM	16	BARREL	40	MACHINE
17	MOTION	41	WHISTLE	17	MOTHER	41	COLOUR
18	RECORD	42	PUPIL	18	APPLE	42	STEAMER
19	ARRAY	43	MESSAGE	19	FUNCTION	43	WELCOME
20	PUZZLE	44	AFFAIR	20	DEVICE	44	ANSWER
21	TEACHER	45	CONGRESS	21	OVEN	45	ROBBER
22	GARMENT	46	TREASURE	22	WEDDING	46	WINTER
23	CARBON	47	SLIPPER	23	BRIDGE	47	SURVEY
24	PERSON	48	JACKET	24	CHANNEL	48	REQUEST

Appendix 2.2 Training Phase Word List from Experiment 1

	NON-WORD		WORD
1	SOTE	31	HANG
2	GLAF	32	WASH
3	GINP	33	FARE
4	CHUR	34	SAFE
5	FLOU	35	GAME
6	AELT	36	DRIP
7	BILP	37	BEND
8	GORT	38	BACK
9	ABST	39	DATE
10	KNOO	40	SEAT
11	AHLL	41	BOAT
12	NOST	42	HALL
13	HIPT	43	TUNE
14	LORT	44	GATE
15	TADE	45	HOME
16	FARB	46	DUST
17	DOOT	47	DESK
18	INPT	48	LOAF
19	SELB	49	MALE
20	FILT	50	SALT
21	ILST	51	PAIN
22	INPS	52	COOK
23	ORTT	53	BEAN
24	LOPT	54	COAT
25	KLIB	55	WALL
26	BLOS	56	HAIR
27	EGST	57	BIRD
28	DELP	58	SINK
29	JOSP	59	YEAR
30	NORT	60	LEAF

Appendix 2.3 Study Instructions from Experiment 1

In this first task you will be presented with a series of words. Each word will appear on the computer screen one at a time. Your task is to make a type of judgements for the first half of the series and a different type of judgement for the other half.

One of the two kinds of judgements that you will have to make is a judgement of the easiness of generating associates of each of the words presented. What you will have to do is to look at the word presented on the screen, think of the meaning of the word and then decide how easy it would be to generate words that are semantically associated to the word you are looking at.. When you see the word on the computer screen, you indicate your decision of how easy it is to generate associates by pressing any of the buttons (appearing on the right hand side of the words) on a scale that goes from 1 to 5. One stands for "very easy", and five for "very difficult". After you have made your choice by pressing any of the buttons, the next word will appear on the screen.

The other type of judgement that you will have to make for the other half of the series of words, is a judgement of the easiness of generating words that rhyme with each of the words presented or the easiness of generating words that sound like the words presented. What you will have to do is to look at the word presented on the screen, think of the sound of the word and then decide how easy it would be to generate words that can rhyme with that word or that have a similar sound to that word. When you see the word on the computer screen, you indicate your decision of how easy it is to generate words that rhyme with it or sound like it by pressing any of the buttons (appearing on the right hand side of the words) on a scale that goes from 1 to 5. One stands for "very easy", and five for "very difficult". After you have made your choice by pressing any of the buttons, the next word will appear on the screen.

Instructions on the screen will tell you which task you will have to carry out first. You will then carry on doing the first task until a new set of instructions will appear on the screen prompting you to carry out the other kind of judgement.

Appendix 2.4 Speeded Responding Training Instructions

In this second task you will see a series of "collections of letters" that may or may not read as a word in the English language. Your task is to make a fast decision on whether the collection of letters is a word or not.

Before each collection of letters is presented, you will first see a set of arrows (>>> <<<) signalling that a collection of letters is about to appear on the screen centred between the arrows. You will then see the collection of letters for a very brief length of time before you will be asked to give your response. You will then see a line of "stars" appearing beneath the collection of letters, only at that stage you can give your response, as quickly as possible, whether the letters that you see make a word or not. If they do, you press the "Yes" button on the keyboard (the "Command key") with the index finger of your right hand; if the letters do not make a word then you press the "No" button on the keyboard (the "Option key") with the index finger of your left hand.

The aim of this task is for you to achieve an optimal responding time from the moment that the row of stars appears. After you have made your response the computer will display how long it took you to make your response from when the row of stars appeared. If you have pressed the button too early, before having a chance of actually seeing the row of stars (i.e. before 50 ms have elapsed) then the computer will tell you that you responded to quickly and you should wait until you see the row of stars. Instead if you take too long to respond (i.e. you took longer than 400 ms) the computer will tell that you responded too slowly and you will have to try and respond faster. If you achieve an optimal responding time (i.e. within 50 ms and 400 ms) the computer will display the message "Good" and you should try to maintain that rate of responding for as many trials as you can.

The computer messages will be displayed for two seconds and then the next word is displayed always preceded by the warning arrows. Carry on with this task until the word "end" is displayed on the computer screen.

Appendix 2.5 Speeded Recognition and Remember and Know Instructions

This task is very similar to the task you just did. In this test you will see a series of words all preceded by a set of arrows signalling that a given word is going to appear centred between the arrows. Some of the words are those that you saw earlier. Others are not. Your task is to make a very fast decision on whether the word you see appearing on the screen was one of the words that appeared in the first task where you had to make the two types of judgement on the easiness of generating associates or similar sounding words. (None of the words that you will see here are the words that were used in the second task where you had to decide whether the collection of letters was a word or not)

For each word, if you recognise the word as one presented earlier, press the "YES" button on the keyboard (the "Command key") with the index finger of your right hand; if you do not think the word was one you saw earlier then you press the "NO" button on the keyboard (the "Option key") with the index finger of your left hand. In the same way as the task that you just did, you will have to make your response on whether you recognise the word or not, very fast (between 50 and 400 ms). The computer will still display your response time and you should try and keep within the optimal responding time boundaries for all your responses.

When you press the YES button indicating that you recognise the word as one of those presented earlier, regardless whether you kept your response between the time boundaries or not, you will be asked to indicate what "kind of recognition" you experienced when you saw the word. Recognition memory is associated with two different kinds of awareness. Quite often recognition brings back to mind something you recollect about what it is that you recognise, as when, for example, you recognise someone's face, and perhaps Remember talking to this person at a party the previous night. At other times recognition brings nothing back to mind about what it is you recognise, as when, for example, you are confident that you recognise someone, and you Know you recognise them, because of strong feelings of familiarity, but you have no recollection of seeing this person before. You do not Remember anything about them.

The same kinds of awareness are associated with recognising the words you saw earlier. Sometimes when you recognise a word as one you saw earlier, recognition will bring back to mind something you Remember thinking about when the word appeared then. You recollect something you consciously experienced at that time. But sometimes recognising a word as one you saw earlier will not bring back to mind anything you Remember about seeing it then. Instead, the word will seem familiar, so that you feel confident it was one you saw earlier, even though you don't recollect anything you experienced when you saw it then.

For each word that you recognise, after you have pressed the YES button, as quickly as possible, please then click the screen button labelled REMEMBER, if recognition is accompanied by some recollective experience, or the screen button KNOW, if recognition is accompanied by strong feelings of familiarity in the absence of any recollective experience.

There will also be times when you decide that your YES response is really just a guess, please then click the screen button GUESS.

There is no time limit for you to indicate what type of recognition you experience (i.e. for pressing the Remember, Know or Guess button),however what you will have to decide very fast is whether you recognise the word or not in the first place by pressing the Yes or No button. *Very* occasionally, you might make a mistake at this stage as you will have to respond so fast, if you do and therefore you cannot then say whether you can "Remember" or "know" or "Guess" the word previous occurrence you can press the "Pass" button. However try and make as few mistakes as possible when you press the "Yes" or "No" button. Also each time that you make a yes response followed by a Remember, Know or Guess decision, click the mouse once to carry on the presentation of the next word.

Appendix 2.6 Participants Data from Experiment 1

SS	Time (ms)	Shall. R	Shall. K	Shall. G	Deep R	Deep K	Deep G	FA R	FA K	FA G
s1	1500	.38	.21	.08	.58	.17	.12	.02	.04	.06
s3	1500	.25	.12	.00	.75	.04	.00	.04	.06	.02
s5	1500	.58	.04	.00	.71	.12	.00	.02	.02	.00
s7	1500	.04	.21	.00	.42	.08	.08	.00	.02	.02
s9	1500	.46	.33	.00	.79	.08	.00	.00	.17	.04
s11	1500	.33	.50	.08	.75	.04	.04	.02	.00	.04
s13	1500	.29	.25	.17	.67	.25	.04	.00	.10	.10
s15b	1500	.46	.25	.08	.62	.21	.00	.02	.19	.06
s17	1500	.46	.12	.12	.50	.17	.04	.00	.02	.06
s19	1500	.50	.04	.04	.50	.04	.00	.08	.00	.00
s21	1500	.12	.17	.00	.58	.12	.04	.04	.12	.02
s23	1500	.50	.25	.00	.67	.17	.00	.02	.08	.10
s25	1500	.21	.33	.00	.38	.46	.00	.04	.17	.00
s27	1500	.12	.25	.04	.88	.00	.04	.02	.04	.00
s29	1500	.12	.12	.12	.25	.21	.04	.00	.06	.06
s31	1500	.29	.12	.17	.42	.29	.08	.02	.08	.08
s2	500	.25	.08	.25	.46	.12	.08	.00	.02	.15
s4	500	.50	.04	.00	.67	.08	.00	.02	.06	.00
s6b	500	.54	.12	.00	.58	.04	.00	.00	.12	.06
s8	500	.00	.08	.12	.33	.08	.04	.00	.00	.12
s10	500	.50	.12	.08	.67	.08	.00	.00	.08	.02
s12	500	.42	.12	.04	.75	.08	.00	.04	.15	.10
s14	500	.08	.04	.12	.21	.12	.08	.00	.00	.00
S16	500	.00	.12	.33	.12	.21	.04	.00	.00	.10
s18	500	.83	.00	.00	.83	.00	.00	.04	.06	.00
s20	500	.08	.12	.00	.12	.04	.00	.00	.00	.00
s22	500	.17	.12	.12	.54	.04	.08	.00	.06	.04
s24b	500	.04	.17	.17	.29	.17	.12	.00	.02	.08
s26	500	.25	.17	.25	.21	.12	.00	.02	.08	.17
s28	500	.21	.04	.00	.50	.21	.00	.04	.15	.02
s30	500	.17	.12	.04	.04	.04	.21	.00	.00	.06
s32b	500	.46	.12	.08	.58	.00	.00	.00	.00	.04

Appendix 2.7 Word Lists from Experiment 2: List A and B

LIST A	*Generate questions*
EXCISE	Tax collected by custom and ...
BRANCH	Leaves hang from this part of the tree...
QUAKER	Member of Christian sect which denies rituals, etc.
FAMINE	Extreme scarcity of food...
HEAVEN	Opposite of hell...
FLEECE	Wool shorn from sheep...
HORROR	Type of frightening film - maybe 'PG' rated...
WALLET	Small folding leather case to hold paper money...
NOTICE	Warning or announcement, often pinned up on a board...
OFFICE	Functional room in which secretary might work...
JUNGLE	Land of tangles vegetation and wild beasts...
DEFEAT	Not a victory...
CORNER	Little Jack Horner sat in this angle of the room...
FOREST	Large wooded area of trees...
CHURCH	Building for public Christian worship...
DAMSON	Small dark-purple plum...
OUTING	Short trip or journey, maybe to the zoo...
DISCUS	Heavy circular object thrown in competitive athletics...
GUITAR	Musical instrument played with a plectrum
SUPPER	Little Tommy Tucker sang for this meal...
SALMON	Pink fish, maybe tinned or smoked...
IMMUNE	Someone who cannot get the disease is...
ENDING	Concluding part of book, maybe a happy one...
INSTEP	Arch of foot between toe and ankle...
FRIEND	Opposite of enemy...
LATHER	Froth of soap and water...
RUSTLE	Sound of blowing leaves...
CARPET	Woven fabric that covers floor...
JACKET	Coat-like garment for upper part of the body...
THIRST	Desire for drink...
CIRCLE	Not a square...
MODERN	Not olden times, but up to date...
STABLE	Building in which horses are kept...
PIGEON	Bird seen in Trafalgar Square...
INFANT	Baby, or child at the earliest stage of life...
ANCHOR	Heavy iron appliance used to secure ship...
HATRED	A feeling of intense dislike...
SPIDER	Insect that spins web...
MELODY	Sweet or tuneful piece of music...
MAIDEN	Olden term for lass or unmarried girl...

LIST B	*Generate questions*
QUIVER	Case for arrows...
SIGNAL	A train driver may obey this directive...
VANITY	Pride or conceit about one's appearance...
TRANCE	Hypnotic state for a medium to contact the d
ACCENT	A Londoner may speak with a cockney one .
TARGET	Object or area to aim at...
LENTIL	Pea-like vegetable, often in soup...
PENCIL	Instrument for drawing or writing...
SLEEVE	Part of garment covering arm...
TROUGH	A pig eats out of this...
VIOLIN	Yehudi Menhuin plays this instrument...
RIBBON	Piece of material worn in hair...
RADISH	Small pungent root, eaten raw in salad...
LOCKET	Heart-shaped pendant to hold photo of loved
POLLEN	Fertilizing powdery substance of flower...
BANDIT	A 'fruit machine' or 'one armed'...
ORANGE	Reddish-yellow citrus fruit...
EMPIRE	Place ruled by emperor. The British had one
TONGUE	Organ of taste in mouth...
VOLUME	Sound control on radio...
BUNION	Painful swelling of first join of big toe...
WEALTH	Riches or affluence...
COUPLE	A pair, perhaps married or engaged...
PRINCE	Son of king or queen
MISERY	Intense unhappiness or suffering...
UMPIRE	Person who rules on disputes in game...
ROSARY	String of beads used in prayer
ADVICE	An agony aunt might give this...
PANTRY	Another word for larder...
PUPPET	Small doll worked by strings...
READER	The person for whom the author writes...
GROUND	Not up in the air but on the...
CHEESE	Dairy product, perhaps Edam or Brie...
MOTHER	Female parent...
SCREEN	You watch films on a silver one of these...
DRIVER	Person at the wheel of a car...
ARMOUR	Suit of metal worn by medieval warriors...
HYPHEN	Dash used to join or divide words...
PREFIX	Opposite of suffix...
NATURE	A person true character or ...

Appendix 2.8 Participants' Data from Experiment 2

Ss	Time	Read R	Read K	Read G	Gen. R	Gen. K	Gen. G	FA R	FA K	FA G
s1	500	.00	.15	.05	.10	.25	.00	.00	.05	.00
s2	500	.00	.05	.00	.05	.00	.00	.00	.03	.00
s5	500	.05	.10	.05	.40	.15	.00	.08	.12	.03
s6	500	.10	.05	.05	.35	.00	.00	.03	.05	.03
s9	500	.00	.15	.00	.00	.05	.00	.00	.10	.00
s10	500	.00	.30	.00	.65	.10	.00	.10	.20	.00
s13	500	.05	.20	.05	.30	.15	.00	.03	.05	.08
s14	500	.00	.05	.05	.05	.05	.05	.00	.03	.03
s17	500	.05	.25	.05	.15	.40	.00	.00	.03	.08
s18	500	.10	.05	.20	.10	.15	.05	.00	.00	.03
s21	500	.00	.10	.00	.15	.45	.10	.05	.20	.00
s22	500	.10	.40	.05	.20	.25	.10	.00	.22	.03
s25	500	.05	.00	.00	.05	.05	.10	.00	.03	.00
s26	500	.20	.15	.10	.25	.05	.10	.05	.00	.05
s29	500	.20	.25	.00	.25	.20	.00	.08	.15	.03
s30	500	.15	.15	.00	.15	.30	.15	.08	.08	.00
S33	500	.15	.00	.00	.05	.05	.00	.00	.10	.03
S34	500	.05	.00	.00	.05	.00	.00	.00	.00	.00
S37	500	.20	.20	.05	.40	.15	.00	.05	.20	.03
S38	500	.15	.30	.00	.15	.10	.00	.00	.12	.07
s3	1500	.10	.25	.25	.10	.20	.20	.03	.08	.20
s4	1500	.05	.25	.10	.20	.20	.00	.00	.00	.00
s7	1500	.20	.20	.00	.20	.00	.15	.10	.20	.05
s8	1500	.25	.25	.00	.20	.25	.00	.03	.15	.00
s11	1500	.00	.15	.00	.15	.35	.05	.00	.03	.03
s12	1500	.25	.20	.05	.25	.50	.00	.05	.32	.03
s15	1500	.05	.05	.00	.05	.35	.00	.00	.03	.00
s16	1500	.20	.15	.15	.30	.05	.05	.05	.08	.10
s19	1500	.05	.25	.10	.00	.30	.05	.00	.03	.08
s20	1500	.05	.15	.10	.40	.00	.10	.00	.03	.08
s23	1500	.10	.10	.05	.50	.10	.00	.00	.00	.03
s24	1500	.05	.15	.00	.05	.10	.00	.00	.03	.00
s27	1500	.30	.30	.00	.35	.15	.00	.00	.08	.00
s28	1500	.10	.05	.00	.40	.40	.00	.00	.10	.00
s31	1500	.25	.15	.15	.10	.45	.00	.00	.17	.10
s32	1500	.15	.45	.00	.05	.45	.00	.03	.03	.17
S35	1500	.20	.15	.00	.55	.05	.00	.00	.05	.00
S36	1500	.20	.15	.00	.30	.20	.00	.00	.00	.00
S39	1500	.00	.20	.00	.35	.15	.00	.05	.12	.00
S40	1500	.10	.30	.00	.05	.15	.00	.03	.12	.00

Appendix to Chapter 3

Appendix 3.1 Design of Experiment 3

Tot no. Of word-pairs = 216
Word-pairs of High association strength = 72
Word-pairs of Medium association strength = 72
Word-pairs of Low association strength = 72
6 lists of 36 word-pairs: A,B,C,D,E,F

Each list has 12 word-pairs of high association strength, 12 with medium and 12 with low. Study list: Target word-pairs = 144 Distractor word-pairs = 72
Design: (The same design is repeated for incidental and intentional retrieval conditions)

		graphemic	semantic	phonemic	self-related	distractors
I	1	A	B	C	D	EF
	2	F	A	B	C	DE
	3	E	F	A	B	CD
	4	D	E	F	A	BC
	5	C	D	E	F	AB
	6	B	C	D	E	FA
		phonemic	**self-related**	**graphemic**	**semantic**	
II	1	A	B	C	D	EF
	2	F	A	B	C	DE
	3	E	F	A	B	CD
	4	D	E	F	A	BC
	5	C	D	E	F	AB
	6	B	C	D	E	FA
		semantic	**phonemic**	**self-related**	**graphemic**	
III	1	A	B	C	D	EF
	2	F	A	B	C	DE
	3	E	F	A	B	CD
	4	D	E	F	A	BC
	5	C	D	E	F	AB
	6	B	C	D	E	FA
		self-related	**graphemic**	**semantic**	**phonemic**	
IV	1	A	B	C	D	EF
	2	F	A	B	C	DE
	3	E	F	A	B	CD
	4	D	E	F	A	BC
	5	C	D	E	F	AB
	6	B	C	D	E	FA

Appendix 3.2 Word-Pairs List of Experiment 3

High Associates: Range 45%-65%

	CUE	TARGET	Assoc. strength	CUE	TARGET	Assoc. strength
1	KNOCK	DOOR	45	TRIGGER	GUN	54
2	TURQUOISE	BLUE	45	LOCK	KEY	55
3	FURNACE	FIRE	45	SOBER	DRUNK	56
4	GOLD	SILVER	46	DISORDER	CHAOS	56
5	WATCH	TIME	46	GLOBE	WORLD	56
6	TRUCK	LORRY	46	LOFT	ATTIC	56
7	HEAVEN	HELL	47	GLEAM	SHINE	56
8	MONTH	YEAR	47	DISMOUNT	HORSE	57
9	ARM	LEG	47	WITTY	FUNNY	57
10	CROWD	PEOPLE	48	ESTUARY	RIVER	57
11	DISAPPEAR	VANISH	48	ATTEMPT	TRY	58
12	BLOSSOM	FLOWER	48	CIGAR	SMOKE	58
13	TEPID	WARM	48	TIMID	SHY	58
14	GRUMBLE	MOAN	48	CARTON	MILK	58
15	BUSH	TREE	48	DISAGREE	ARGUE	59
16	BANQUET	FEAST	49	DOCUMENT	PAPER	59
17	MOVIE	FILM	49	EXPLOSIVE	BOMB	59
18	BEGIN	START	49	NOVEL	BOOK	60
19	THICK	THIN	49	THUNDER	LIGHTENING	60
20	FRONT	BACK	49	ARID	DRY	60
21	PUPPET	STRING	50	THEN	NOW	60
22	CONCEPT	IDEA	50	CLAP	HANDS	61
23	CUP	SAUCER	51	AUNT	UNCLE	61
24	CASH	MONEY	52	HARE	RABBIT	61
25	MAN	WOMAN	51	STING	BEE	62
26	BEAK	BIRD	52	WHITE	BLACK	62
27	CONTENT	HAPPY	52	QUID	POUND	62
28	GIFT	PRESENT	52	FRAGRANCE	SMELL	62
29	RECORD	TAPE	52	TORSO	BODY	62
30	COOKIE	BISCUIT	52	BROTH	SOUP	63
31	TRIP	FALL	52	KING	QUEEN	63
32	TRUE	FALSE	53	UMBRELLA	RAIN	63
33	DIFFICULT	HARD	53	NEAR	FAR	64
34	BARK	DOG	54	COT	BABY	64
35	CHALK	CHEESE	54	COB	CORN	64
36	BAKE	CAKE	54	STROLL	WALK	65

Medium Associates: Range 25%-45%

	CUE	TARGET	Assoc. strength	CUE	TARGET	Assoc. strength
1	ATHLETE	RUNNER	25	SPIRIT	GHOST	33
2	PRAY	CHURCH	25	LINK	CHAIN	34
3	DISEASE	ILLNESS	26	PLUG	SOCKET	35
4	BANDAGE	WOUND	26	SCAFFOLD	BUILDING	35
5	PUPIL	TEACHER	26	REMARK	COMMENT	35
6	CARROT	STICK	26	JAIL	PRISON	36
7	RUMOUR	GOSSIP	26	BATTLE	WAR	36
8	APPLE	PEAR	26	APE	MONKEY	36
9	DIRTY	CLEAN	27	HAIRBRUSH	COMB	36
10	FANTASY	DREAM	27	CONVERT	CHANGE	36
11	HONESTY	TRUTH	27	SQUIRREL	NUT	36
12	POSTCARD	HOLIDAY	27	JEALOUSY	ENVY	37
13	ASHTRAY	CIGARETTE	28	UNIVERSITY	COLLEGE	37
14	BARRACK	ARMY	28	BACTERIA	GERM	38
15	BUN	OVEN	27	TONIC	GIN	38
16	PARCEL	POST	29	TANKER	OIL	38
17	DISH	PLATE	29	SECTION	PART	39
18	DOVE	PEACE	29	RICH	POOR	39
19	DIG	HOLE	29	SPOON	FORK	39
20	BOOT	SHOE	30	CAUSE	EFFECT	40
21	TENANT	LANDLORD	30	BAD	GOOD	40
22	APPLICANT	JOB	31	TEA	COFFEE	40
23	BALLET	DANCE	31	DIESEL	ENGINE	40
24	CARPENTER	WOOD	31	NEGATIVE	POSITIVE	41
25	CELLO	VIOLIN	31	BARREL	BEER	42
26	UNKIND	CRUEL	31	ROUGH	SMOOTH	41
27	GIVE	TAKE	31	FULL	EMPTY	42
28	RUG	CARPET	31	SHIVER	SHAKE	42
29	SNOOKER	BALL	31	STORY	TALE	42
30	BARE	NAKED	31	KEYBOARD	PIANO	42
31	BASIC	SIMPLE	31	ALCOHOL	DRINK	43
32	ROMANCE	LOVE	32	EDUCATION	SCHOOL	43
33	DRENCH	WET	32	TAVERN	PUB	43
34	ACROBAT	CIRCUS	33	BALLOT	VOTE	43
35	FABRIC	CLOTH	33	CHAT	TALK	44
36	HOT	COLD	33	FLOOD	WATER	44

Low Associates: Range 5%-25%

	CUE	TARGET	Assoc strength	CUE	TARGET	Assoc. strength
1	TEASE	JOKE	6	CUTE	SWEET	14
2	TRAVEL	PLANE	7	TEETH	MOUTH	15
3	HOUSEHOLD	CHORE	8	CASTLE	SAND	15
4	TRAIN	STATION	8	INJUSTICE	LAW	15
5	CLUMSY	AWKWARD	9	IRON	STEEL	16
6	CHILD	MOTHER	9	ANGER	RAGE	17
7	LEAN	MEAT	9	AMBULANCE	HOSPITAL	17
8	CAR	DRIVE	9	BARGAIN	SALE	17
9	DIAMOND	JEWEL	9	DETECTIVE	POLICE	17
10	GREEK	LATIN	9	FIELD	GRASS	17
11	PASSAGE	INDIA	9	DESK	WORK	17
12	BARON	KNIGHT	9	SCARF	NECK	18
13	SPEAR	HEAD	9	SANDWICH	BREAD	18
14	SHARE	GIVE	9	SHEEP	WOOL	18
15	STRICT	SEVERE	10	CITIZEN	PERSON	19
16	TABLECLOTH	CHECK	10	BEAR	HUG	19
17	EXCITEMENT	FUN	10	FASHION	CLOTHES	19
18	OMINOUS	CLOUD	10	COUPLE	PAIR	19
19	BOWL	FRUIT	11	FAILURE	SUCCESS	20
20	GATE	FENCE	11	FOOTBALL	PLAYER	20
21	WAISTCOAT	JACKET	11	CELLAR	BASEMENT	21
22	AUTHORITY	GOVERNMENT	12	REALM	KINGDOM	21
23	TRAGEDY	COMEDY	12	LETTUCE	CABBAGE	21
24	CARD	BIRTHDAY	12	HOME	HOUSE	21
25	LEATHER	BELT	12	SEASON	SPRING	21
26	DEFENCE	ATTACK	12	BADMINTON	RACKET	21
27	HANDBAG	PURSE	13	RISK	DANGER	22
28	SERVICE	WAITER	13	CALORIE	DIET	22
29	BALCONY	VERANDA	13	TIE	KNOT	23
30	CALCULATE	SUM	13	BOAT	SHIP	23
31	PILL	TABLET	14	ARTIST	PAINT	24
32	CHAOTIC	MAD	14	STRAIGHT	NARROW	24
33	HAM	EGG	14	INNOCENT	GUILTY	24
34	HORIZON	SEA	14	MARTIAN	ALIEN	24
35	AXE	CHOP	14	PENCIL	PEN	24
36	TALENT	SKILL	14	RURAL	COUNTRY	24

Appendix 3.3 Experiment 3 Study Tasks' Instructions

Instructions

In this study we will ask you to carry out some simple operations in response to two stimulus words presented to you at the same time. You will be required to:

a) Decide which one of the two words has more letters that extend above the main body of the word (e.g. b,f,t)

b) Decide which one of the two words has more syllables

c) Decide which one of the two words has the most pleasant meaning

d) Decide which one of the two words is more important to you now or in the future.

A set of instructions at the top of the screen will remind you what operation (a,b,c or d) you should carry out. You carry out the same operation for a series of 36 word-pairs and then the instructions will change prompting you to carry out the next operation on the list with other word-pairs.

Appendix 3.4 Experiment 3 Retrieval Test Instructions

Incidental retrieval instructions

In this task you will see a series of words presented to you one at a time. As you see one word, your task is to say aloud the first word that it brings to mind which is associated to it. We are interested in the word that comes to mind immediately, not after thinking about it for a while.

You may find that some of the words you see are the same words as the words you saw earlier in the previous separate task and sometimes you may find that the first words that spring to mind are also words you saw before. This is because there is some overlap in the material we are using for these separate tasks. Nevertheless I would like you to disregard what happened before and always write down the first word that spring to mind first, whether you saw the word earlier or not.

To begin this task, press the "go" button.

Intentional retrieval instructions

In this task you will see a series of words presented to you one at a time. Most of these words will be the same words as the one you saw on the left hand-side of the screen in the previous task. Your task is to use the word on the screen as a cue to remember the associated word that you saw appearing on the right hand-side of the screen at the same time in the previous task. You should not expect to be able to remember the associate of all the words you will see presented on the screen, as some of these words do not correspond to the previous words.

If you remember the second associated word and you are positive that you saw the two words together, then I would like you to say aloud that associated word. If you find that you cannot remember seeing the word before or you cannot recall the associated second word, you can say "pass" for that word.

To begin this task, press the "go" button.

Appendix 3.5. Participants' Data from Experiment 3

Ss	cond	Gr H	Gr M	Gr L	Ph H	Ph M	Ph L	Se H	Se M	Se L	Sr H	Sr M	Sr L	ds H	ds M	ds L
s02	Inc	1	.42	.25	.67	.5	.33	.83	.58	.5	.83	.67	.67	.62	.33	.12
s04	Inc	.83	.5	.33	.67	.5	.42	1	.75	.33	1	.67	.42	.67	.21	.12
s06	Inc	.58	.33	0	.42	.5	.25	.58	.83	.58	.83	.67	.58	.46	.42	.17
s08	Inc	.5	.33	.33	1	.5	.5	.92	.67	.75	1	1	.5	.62	.42	.33
s10	Inc	.42	.42	.25	.58	.42	.33	.75	.42	.33	.58	.42	.5	.46	.46	.17
s12	Inc	.5	.58	0	.58	.42	.17	.75	.33	.5	.58	.75	.58	.38	.38	.17
s14	Inc	.83	.5	.33	1	.75	.25	.92	.83	.33	.83	.83	.58	.62	.58	.08
s16	Inc	.5	.58	0	.58	.5	.33	.58	.42	.17	.67	.42	.33	.58	.42	.17
s18	Inc	.67	.33	.08	.67	.58	.25	.67	.75	.5	.67	.58	.33	.5	.54	.17
s20	Inc	.33	.08	.08	.67	.17	.25	.5	.17	.17	.33	.33	.08	.42	.17	.17
s22	Inc	.67	.33	.42	.75	.58	.33	.67	.83	.17	.67	.33	.25	.79	.46	.17
s24	Inc	.67	.5	.25	.75	.58	.33	.75	.92	.33	.75	.58	.67	.67	.62	.21
s26	Inc	.25	.17	.25	.67	.58	.17	.33	.33	.17	.33	.33	.08	.71	.33	.17
s28	Inc	.83	1	.42	.92	.75	.42	1	1	.75	.83	1	.83	.67	.54	.25
s30	Inc	.42	.5	.17	.67	.42	.42	.75	.5	.42	.75	.58	.33	.46	.25	.17
s32	Inc	.5	.33	.17	.42	.17	.17	.42	.33	.33	.5	.5	0	.38	.33	.08
s34	Inc	.58	.08	.17	.58	.58	.08	.58	.67	.33	.67	.67	.42	.71	.42	.17
s36	Inc	.33	.5	.08	.5	.25	.08	.58	.33	.33	.42	.5	.08	.58	.12	.12
s38	Inc	.58	.42	.08	.67	.25	.25	.58	.5	.33	.67	.5	.25	.5	.38	.08
s40	Inc	.75	.33	.17	.83	.58	.5	.75	.5	.42	.58	.67	.42	.42	.42	.17
s42	Inc	.75	.75	.25	.92	.67	.42	1	.75	.67	1	.58	.67	.58	.58	.25
s44	Inc	.67	.42	.17	.75	.58	.33	.83	.92	.33	.83	.75	.58	.96	.5	.29
s46	Inc	.75	.33	.17	.67	.33	.5	.92	.75	.58	.67	.92	.67	.54	.46	.21
s48	Inc	.33	.17	.17	.33	.5	0	.58	.17	.42	.5	.42	.08	.25	.38	.12
s01	Int	.25	.08	.08	.33	.08	0	.83	.67	.17	1	.75	.83	0	0	0
s03	Int	0	0	0	.42	.75	.42	1	.92	.67	.75	.92	.92	0	0	0
s05	Int	0	0	.25	.08	.42	.17	.67	.92	.83	.75	.75	.5	0	0	0
s07	Int	.08	.08	0	0	.08	.08	.25	.58	.5	.33	.67	.67	0	.04	0
s09	Int	0	.08	.25	.25	.42	.25	.75	.67	.5	.58	.42	.58	0	0	0
s11	Int	.25	.17	0	.08	.17	0	.25	.42	.33	.5	.33	.33	0	0	0
s13	Int	0	0	0	0	0	0	.5	.58	.75	.5	.33	.75	0	.04	0
s15	Int	0	0	0	0	.17	0	.75	.83	.67	.42	.58	.58	0	0	0
s17	Int	.17	0	0	.08	.08	.17	.67	.92	.67	.67	.75	.83	0	0	0
s19	Int	.08	.17	0	.25	.08	0	.83	.83	.58	.58	.83	.67	0	0	0
s21	Int	.25	.17	.08	.42	.25	.25	1	.67	.58	.67	.75	.83	.04	0	0
s23	Int	.17	.08	0	.25	.42	.25	1	1	.92	.58	.58	.67	.04	0	0
s25	Int	.25	.25	.08	.25	.17	.08	.92	.5	.5	.75	.92	.58	.08	0	0
s27	Int	0	0	0	0	0	0	.67	.5	.25	.5	.67	.67	0	0	0
s29	Int	.08	.08	.08	.33	.08	0	.75	.25	.5	.42	.75	.5	0	0	0
s31	Int	.08	.33	.17	.25	.08	.08	.58	.58	.25	.67	.67	.58	.04	.04	0
s33	Int	0	0	0	.08	0	0	.58	.83	.33	.5	.42	.25	0	0	0
s35	Int	.17	0	0	.33	.42	.58	1	1	.92	.92	.92	1	0	0	0
s37	Int	0	.08	.08	.17	.25	.42	1	1	1	.92	1	.92	0	0	0
s39	Int	.58	.33	.17	.33	.33	.17	.83	.92	.83	.92	.92	.58	0	.04	0
s41	Int	.25	.25	.33	.75	.5	.33	1	1	1	.92	.92	1	0	0	0
s43	Int	0	0	0	.25	.17	.17	.83	1	.75	.83	.67	.67	0	0	0
s45	Int	0	0	0	0	.25	.08	.5	.92	.67	.67	.67	.58	0	0	0
s47	Int	.08	.17	0	.17	.17	.17	.92	.75	.67	.58	.67	.67	.04	0	0

Appendix 3.6 Item Analysis Data from Experiment 3

			Incid					Inten				
cue	target	ass	graph	pho	sem	self-	unst	Grap	pho	sem	self-	unst
LOW												
tease	joke	6	.25	.25	.50	.75	.00	.00	.00	.75	1.00	.00
travel	plane	7	.00	.25	.25	.25	.25	.00	.00	.50	.50	.00
household	chore	8	.00	.00	.00	.25	.00	.00	.50	.50	.25	.00
train	station	8	.00	.00	.00	.50	.00	.00	.25	.75	.75	.00
baron	knight	9	.00	.25	.50	.25	.00	.00	.00	.25	.25	.00
car	drive	9	.00	.25	.00	.50	.25	.00	.00	1.00	.50	.00
child	mother	9	.25	.00	.75	.50	.00	.25	.25	1.00	.50	.00
clumsy	awkward	9	.00	.25	.00	.50	.38	.00	.00	.00	.50	.00
diamond	jewel	9	.25	.25	.50	.50	.00	.25	.25	.75	1.00	.00
Greek	Latin	9	.50	.00	.25	.50	.00	.00	.25	1.00	1.00	.00
passage	India	9	.00	.00	.50	.00	.00	.00	.00	.50	.50	.00
share	give	9	.00	.50	.75	.50	.12	.00	.25	1.00	1.00	.00
spear	head	9	.25	.00	.00	.00	.00	.25	.00	.25	.50	.00
excitement	fun	10	.00	.25	.75	.25	.12	.00	.00	1.00	.75	.00
ominous	cloud	10	.00	.00	.25	.00	.00	.25	.00	.25	.00	.00
strict	severe	10	.00	.00	.00	.25	.12	.00	.25	.50	.50	.00
sword	fight	10	.00	.25	.25	.50	.00	.00	.00	.00	.25	.00
tablecloth	check	10	.00	.00	.00	.25	.00	.00	.00	.25	.00	.00
bowl	fruit	11	.25	.00	.00	.25	.00	.00	.00	.00	.75	.00
gate	fence	11	.00	.25	.50	.25	.12	.00	.00	.75	.50	.00
waistcoat	jacket	11	.25	.25	.25	.50	.38	.00	.25	1.00	.50	.00
authority	Govern.	12	.00	.00	.50	.00	.12	.00	.00	.75	.50	.00
card	birthday	12	.75	.75	.25	.50	.25	.50	.00	.25	.00	.00
defence	attack	12	.00	.25	.25	.25	.00	.00	.00	.75	.50	.00
leather	belt	12	.25	.50	.25	.25	.12	.00	.25	1.00	1.00	.00
tragedy	comedy	12	.00	.25	.25	.00	.00	.00	.00	1.00	1.00	.00
balcony	veranda	13	.00	.25	.25	.50	.00	.25	.25	.00	1.00	.00
calculate	sum	13	.00	.25	.75	.00	.12	.00	.25	.25	.25	.00
handbag	purse	13	.25	.25	.50	1.00	.12	.00	.50	.50	.75	.00
service	waiter	13	.50	.00	.00	.50	.12	.00	.00	.25	.25	.00
axe	chop	14	.00	.00	.25	.25	.12	.00	.00	.50	.75	.00
chaotic	mad	14	.25	.25	.00	.25	.00	.00	.25	.75	.00	.00
cute	sweet	14	.50	.75	1.00	.25	.38	.25	.00	1.00	.75	.00
ham	egg	14	.25	.00	.25	.25	.12	.25	.75	.75	.75	.00
horizon	sea	14	.00	.00	.00	.75	.38	.00	.00	.50	.75	.00
pill	tablet	14	.00	.50	.50	.25	.38	.00	.50	1.00	1.00	.00
talent	skill	14	.00	.25	.75	.25	.00	.00	.00	.75	.75	.00
castle	sand	15	.00	.25	.00	.25	.00	.25	.50	.25	.25	.00
injustice	law	15	.00	.25	.50	.25	.00	.00	.00	.75	.75	.00
teeth	mouth	15	.00	.50	.50	.00	.12	.25	.25	1.00	1.00	.00
iron	steel	16	.00	.00	.50	.50	.00	.00	.00	.75	1.00	.00
ambulance	hospital	17	.00	.50	.25	.25	.12	.25	.25	1.00	1.00	.00
anger	rage	17	.50	.00	.75	.50	.00	.00	.00	.00	.50	.00
bargain	sale	17	.00	.75	1.00	1.00	.25	.00	.25	1.00	1.00	.00
desk	work	17	.00	.25	.00	.50	.25	.00	.00	.75	1.00	.00
detective	police	17	.00	.25	.25	1.00	.38	.00	.50	.50	1.00	.00
field	grass	17	.00	.25	.75	.25	.12	.00	.00	.25	.75	.00
sandwich	bread	18	.25	.00	.25	.50	.25	.00	.00	1.00	1.00	.00
scarf	neck	18	.50	.25	.75	.25	.00	.25	.00	.50	.25	.00
sheep	wool	18	.25	.00	.00	.25	.12	.00	.00	.75	.75	.00
bear	hug	19	.25	.25	.75	.50	.25	.00	.00	.50	.50	.00
citizen	person	19	.50	.75	.75	1.00	.50	.00	.25	.50	.00	.00
couple	pair	19	.50	.25	1.00	.50	.12	.25	.00	.75	1.00	.00
fashion	clothes	19	.25	.75	.25	.75	.62	.25	.00	.50	1.00	.00
failure	success	20	.00	.75	.50	.50	.12	.25	.00	.75	1.00	.00
football	player	20	.25	.25	.25	.00	.12	.00	.25	1.00	.75	.00
badminton	racket	21	.50	.50	.50	.50	.12	.00	.50	1.00	.75	.00

cellar	basement	21	.25	.25	.50	1.00	.00	.00	.50	.75	.50	.00
home	house	21	.75	.75	1.00	.50	.62	.00	.50	1.00	1.00	.00
lettuce	cabbage	21	.50	.50	.00	.25	.00	.00	.25	.75	1.00	.00
realm	kingdom	21	.00	.25	.00	.50	.25	.00	.00	.25	.50	.00
season	spring	21	.00	.75	.25	.50	.25	.00	.00	.75	1.00	.00
calorie	diet	22	.50	.25	.50	.75	.25	.00	.00	.75	.75	.00
risk	danger	22	.25	.25	.75	1.00	.12	.00	.00	.75	.50	.00
boat	ship	23	.00	.75	.75	.75	.25	.00	.25	.50	.75	.00
tie	knot	23	.50	.00	.50	.50	.12	.00	.00	.00	1.00	.00
artist	paint	24	.25	.50	.00	.50	.38	.00	.25	.75	.50	.00
innocent	guilty	24	.00	.75	1.00	1.00	.25	.25	.75	.00	1.00	.00
martian	alien	24	1.00	.75	.75	.75	.50	.00	.00	.50	1.00	.00
pencil	pen	24	.50	.50	.75	.50	.38	.25	.50	1.00	1.00	.00
rural	country	24	.25	.75	.75	.50	.62	.25	.00	.75	.75	.00
straight	narrow	24	.25	.00	1.00	.50	.38	.00	.25	.50	.50	.00
MEDIUM												
athlete	runner	25	.25	.75	.75	.75	.25	.00	.00	.75	1.00	.00
pray	church	25	.25	.50	.50	.75	.00	.25	.25	1.00	1.00	.00
apple	pear	26	.50	.50	.50	.00	.38	.00	.75	.50	.75	.00
bandage	wound	26	.00	.25	.25	.25	.12	.00	.25	.75	.25	.00
carrot	stick	26	.00	.00	.50	.00	.12	.00	.00	.25	.75	.00
disease	illness	26	.50	.50	.75	.75	.12	.25	.25	1.00	1.00	.00
pupil	teacher	26	.00	.25	.00	.25	.25	.00	.25	.75	.75	.00
rumour	gossip	26	.50	.50	.75	.75	.12	.25	.25	1.00	1.00	.00
bun	oven	27	.50	.00	.50	.50	.00	.25	.00	1.00	.25	.00
dirty	clean	27	.00	.50	.50	1.00	.50	.00	.50	.75	.50	.00
fantasy	dream	27	.50	.25	.75	1.00	.75	.00	.25	.75	1.00	.00
honesty	truth	27	.00	.50	.00	1.00	.50	.00	.00	1.00	.75	.00
postcard	holiday	27	.25	.25	1.00	.25	.25	.00	.00	.75	.50	.00
ashtray	cigarettes	28	.50	1.0	.75	.75	.62	.25	.25	1.00	.75	.00
barrack	army	28	.50	.75	.75	.00	.25	.00	.50	.75	.00	.00
dig	hole	29	.50	.75	.75	.00	.12	.00	.00	.50	.25	.00
dish	plate	29	.25	.00	.50	.25	.12	.00	.25	.75	.75	.00
dove	peace	29	.25	.00	.75	.25	.12	.00	.00	.75	.50	.00
parcel	post	29	.00	.50	.25	.25	.00	.00	.00	.50	.50	.00
boot	shoe	30	.50	.50	1.00	.50	.50	.00	.00	1.00	1.00	.00
tenant	landlord	30	.25	.25	.50	1.00	.25	.25	.50	1.00	.50	.00
applicant	job	31	.25	.50	.50	.75	.50	.00	.00	.75	.50	.00
ballet	dance	31	.25	.00	.75	.50	.38	.00	.25	.75	1.00	.12
bare	naked	31	.75	.25	1.00	.50	.50	.25	.00	.75	.75	.00
basic	simple	31	.25	.50	.75	1.00	.50	.25	.25	.75	.75	.00
carpenter	wood	31	.25	.50	.75	1.00	.50	.25	.00	.75	.50	.00
cello	violin	31	.25	1.0	.25	.75	.12	.75	.25	1.00	.75	.00
give	take	31	.25	.75	1.00	1.00	.88	.00	.50	1.00	.50	.00
rug	carpet	31	1.00	.25	.75	.50	.50	.00	.00	.50	.75	.00
snooker	ball	31	.50	.50	.25	.25	.12	.25	.00	.50	1.00	.00
unkind	cruel	31	.50	.25	.50	.25	.00	.00	.25	1.00	.00	.00
drench	wet	32	.50	.75	.75	.75	.25	.00	.25	.25	.00	.00
romance	love	32	.75	.75	.75	.75	.62	.25	.00	1.00	1.00	.00
acrobat	circus	33	.25	.75	.75	.75	.25	.00	.00	.50	.75	.00
fabric	cloth	33	.50	.00	.50	.75	.38	.00	.00	.50	1.00	.00
hot	cold	33	.75	.75	.75	.50	.62	.50	.25	.75	.75	.12
spirit	ghost	33	.50	.75	.50	.50	.50	.00	.00	1.00	1.00	.00
link	chain	34	.25	.75	.75	.75	.50	.00	.00	.75	.75	.00
plug	socket	35	.25	.50	.50	1.00	.38	.00	.25	1.00	.50	.00
remark	comment	35	.50	.25	.25	.75	.25	.00	.00	.75	.75	.00
scaffold	building	35	.75	.75	.75	.50	.50	.25	.25	.25	.50	.00
ape	monkey	36	.50	.75	.75	.75	.25	.00	.50	1.00	1.00	.00
battle	war	36	.25	.00	.50	.75	.50	.00	.25	.50	1.00	.00
convert	change	36	.75	.75	.75	.25	.62	.00	.00	.75	.75	.00
hairbrush	comb	36	.25	.25	.50	1.00	.25	.00	.00	.75	.75	.00
jail	prison	36	.50	.75	1.00	1.00	.75	.25	.75	1.00	.75	.00

squirrel	nut	36	.50	.50	.25	.50	.12	.00	1.00	.25	.75	.00
jealousy	envy	37	.75	.75	.75	.75	.12	.25	.00	.75	1.00	.00
university	college	37	.00	.75	.75	.50	.25	.25	.25	1.00	1.00	.00
bacteria	germ	38	.50	.25	1.00	.50	.50	.00	.75	.75	.75	.00
tanker	oil	38	.00	.75	.50	.75	.50	.00	.00	.75	.50	.00
tonic	gin	38	.50	.00	.50	.50	.62	.25	.75	1.00	.50	.00
rich	poor	39	.50	.75	1.00	.75	.75	.50	.50	1.00	1.00	.00
section	part	39	.25	.25	.50	.50	.50	.00	.00	.75	.50	.00
spoon	fork	39	.50	.50	.50	.50	.50	.00	.25	.75	1.00	.00
bad	good	40	.25	.50	.75	1.00	.38	.25	.75	1.00	.25	.12
cause	effect	40	.75	.25	.50	1.00	.50	.25	.50	1.00	1.00	.00
diesel	engine	40	.25	.00	.00	.50	.38	.00	.00	.50	1.00	.00
tea	coffee	40	1.00	.50	.25	.50	.50	.00	.25	1.00	1.00	.00
negative	positive	41	.50	.50	1.00	1.00	.75	.25	.75	.50	.75	.00
rough	smooth	41	.50	.75	.50	.25	.62	.00	.50	.75	.50	.00
barrel	beer	42	.00	.50	.50	.50	.25	.25	.00	.50	.75	.00
full	empty	42	.50	.50	1.00	1.00	.62	.25	.25	.75	.75	.12
keyboard	piano	42	.25	.50	.50	.50	.38	.00	.00	.75	.75	.00
shiver	shake	42	.00	.00	.25	.25	.00	.00	.00	1.00	.50	.00
story	tale	42	.00	.00	.50	1.00	.25	.00	.00	.75	.50	.00
alcohol	drink	43	.50	1.0	.75	.50	.25	.00	.00	1.00	.75	.00
ballot	vote	43	.50	.00	.25	.50	.25	.00	.00	.50	.75	.00
education	school	43	.50	.75	.50	.75	.62	.00	.00	1.00	.50	.00
tavern	pub	43	.25	.25	.75	1.00	.25	.00	1.00	.75	.50	.00
chat	talk	44	1.00	.75	.25	1.00	.75	.00	.00	.25	1.00	.00
flood	water	44	1.00	.75	1.00	.50	.88	.00	.25	.75	.75	.00
HIGH												
furnace	fire	45	.25	1.0	1.00	.75	.38	.25	.00	.50	.25	.00
knock	door	45	.75	1.0	1.00	.75	.62	.00	.00	.50	.50	.00
turquoise	blue	45	.50	.25	.75	.50	.38	.25	.25	1.00	.75	.00
gold	silver	46	.75	.50	.50	1.00	.50	.00	.25	1.00	1.00	.00
truck	lorry	46	.75	.25	1.00	.50	.25	.00	.25	.75	.75	.00
watch	time	46	.25	.25	.50	1.00	.62	.00	.00	1.00	.75	.00
arm	leg	47	1.00	.75	1.00	1.00	.88	.00	.25	.75	1.00	.00
heaven	hell	47	.25	1.0	.50	.75	.75	.25	.25	1.00	1.00	.00
month	year	47	.50	.50	.75	.50	.50	.25	.25	1.00	.75	.00
blossom	flower	48	.25	.75	1.00	1.00	.62	.00	.00	.75	1.00	.00
bush	tree	48	.50	.75	.75	1.00	.38	.00	.00	1.00	1.00	.00
crowd	people	48	.75	.25	.50	.50	.50	.00	.00	.75	.75	.00
disappear	vanish	48	.50	.25	.75	.75	.25	.00	.00	.75	.75	.00
grumble	moan	48	.25	.00	1.00	.75	.38	.00	.00	1.00	.50	.00
tepid	warm	48	.50	1.0	.50	.50	.50	.25	.25	.75	.75	.00
banquet	feast	49	.25	.25	.50	.50	.00	.00	.00	.50	.25	.00
begin	start	49	.75	1.0	1.00	.50	.62	.00	.50	.50	.75	.12
front	back	49	.75	1.0	.75	1.00	.75	.00	.00	.75	.75	.00
movie	film	49	.50	.75	.75	.75	.75	.00	.25	1.00	1.00	.00
thick	thin	49	.50	1.0	.25	1.00	.62	.25	.25	.75	1.00	.00
concept	idea	50	1.00	.75	.75	.75	.50	.00	.25	.75	1.00	.00
puppet	string	50	.00	.50	.75	1.00	.38	.00	.00	1.00	.25	.00
cup	saucer	51	.25	.25	.50	.50	.38	.00	.00	.50	.50	.00
man	woman	51	1.00	1.0	1.00	1.00	.75	.50	.25	.75	1.00	.00
beak	bird	52	.50	.75	1.00	1.00	.50	.00	.50	1.00	.50	.00
cash	money	52	1.00	1.0	1.00	.75	.75	.25	.75	.75	.75	.00
content	happy	52	.50	.50	.50	.75	.50	.25	.00	.75	.50	.00
cookie	biscuit	52	.50	.50	1.00	.25	.00	.25	.25	.75	.75	.00
gift	present	52	1.00	.75	1.00	.75	.75	.25	.50	.75	1.00	.00
record	tape	52	.25	.25	.00	.75	.12	.00	.00	.75	.50	.00
trip	fall	52	.50	.50	.25	.25	.12	.00	.00	.25	.25	.00
difficult	hard	53	.75	1.0	.50	.50	.75	.00	.50	1.00	.00	.00
true	false	53	.50	1.0	.75	1.00	.75	.25	.75	.75	.50	.12
bake	cake	54	.50	.25	.75	.50	.50	.50	.25	.75	.75	.00
bark	dog	54	.75	.75	1.00	.75	.75	.00	.25	.75	.75	.00
chalk	cheese	54	.50	.25	.75	.75	.12	.00	.00	.50	.25	.00

trigger	gun	54	.75	1.0	.50	.75	.88	.00	.00	1.00	.75	.00
lock	key	55	.50	1.0	.75	.50	.62	.00	.00	.75	.75	.00
disorder	chaos	56	.00	.50	.25	.25	.12	.00	.25	.75	.75	.00
gleam	shine	56	.25	1.0	.25	.50	.38	.00	.25	.75	.25	.00
globe	world	56	.75	.50	.75	1.00	.75	.00	.00	1.00	.75	.00
loft	attic	56	.75	.50	.75	.50	.50	.00	.00	.00	.25	.00
sober	drunk	56	.25	.75	1.00	.75	.62	.25	.75	1.00	.75	.00
dismount	horse	57	.25	.75	.75	.50	.50	.00	.00	.75	.25	.00
estuary	river	57	.50	.50	.00	.75	.75	.00	.25	.50	.75	.00
witty	funny	57	.25	.50	.75	.75	.38	.00	.00	.75	.50	.00
attempt	try	58	1.00	.75	1.00	1.00	.88	.25	.00	1.00	1.00	.12
carton	milk	58	.50	1.0	1.00	.75	.50	.00	.25	1.00	.25	.00
cigar	smoke	58	.75	.25	.75	.25	.25	.00	.00	.50	.75	.00
timid	shy	58	.75	1.0	1.00	1.00	.62	.50	.25	.75	.75	.12
disagree	argue	59	.00	.25	.25	.50	.38	.00	.25	.75	.75	.00
document	paper	59	.75	.75	1.00	.75	.38	.00	.25	.75	.50	.00
explosive	bomb	59	1.00	.25	.25	.50	.50	.00	.25	1.00	.50	.00
arid	dry	60	.50	.50	1.00	.75	.62	.00	.75	.75	.50	.00
novel	book	60	.75	.75	1.00	.75	.62	.00	.25	.75	.75	.12
then	now	60	.25	.75	1.00	.50	.62	.00	.50	.75	.75	.00
thunder	lightning	60	.75	1.0	.50	.50	.50	.25	.25	1.00	1.00	.00
aunt	uncle	61	1.00	1.0	1.00	.75	1.00	.25	.75	1.00	1.00	.00
clap	hands	61	.25	.25	.50	.50	.50	.25	.25	.75	.50	.00
hare	rabbit	61	1.00	1.0	.75	1.00	.88	.25	.25	.25	.50	.00
fragrance	smell	62	.50	.75	.50	.25	.62	.00	.25	.75	.50	.00
quid	pound	62	.50	.75	.25	.75	.12	.25	1.00	.75	.50	.00
sting	bee	62	.75	1.0	.50	.50	.62	.25	.25	1.00	.75	.00
torso	body	62	.75	.00	1.00	.75	.62	.00	.00	1.00	.75	.00
white	black	62	.75	.50	1.00	.25	.88	.25	.00	.75	.75	.12
broth	soup	63	.25	.50	.75	.50	.38	.25	.00	.25	.50	.00
king	queen	63	.75	1.0	.75	1.00	.88	.75	.25	1.00	1.00	.00
umbrella	rain	63	.75	.75	1.00	.75	.88	.25	.00	1.00	1.00	.00
cob	corn	64	.75	.75	.50	.75	.38	.00	.00	.25	.75	.00
cot	baby	64	.75	.75	.75	.75	.75	.25	.00	.50	.50	.00
near	far	64	.25	.25	1.00	.50	.50	.00	.75	.75	.25	.00
stroll	walk	65	1.00	1.0	.75	.75	.88	.25	.00	.25	.75	.00

Appendix to Chapter 4

Appendix 4.1 Design of Experiment 4

Tot. no. Of word-pairs = 168
Word-pairs of High association strength = 84
Word-pairs of Low association strength = 84
6 sets of words: A,B,C,D,E,F
Each list has 14 word-pairs of high association strength, and 14 with low association strength
Study list: Target word-pairs = 112 Distracter word-pairs = 56

Design: (The same design is repeated for incidental and intentional retrieval conditions)

		graphemic	**semantic**	**phonemic**	**image**	**distracters**
I	**1**	**A**	**B**	**C**	**D**	**EF**
	2	**F**	**A**	**B**	**C**	**DE**
	3	**E**	**F**	**A**	**B**	**CD**
	4	**D**	**E**	**F**	**A**	**BC**
	5	**C**	**D**	**E**	**F**	**AB**
	6	**B**	**C**	**D**	**E**	**FA**
		phonemic	**image**	**graphemic**	**semantic**	
II	**1**	**A**	**B**	**C**	**D**	**EF**
	2	**F**	**A**	**B**	**C**	**DE**
	3	**E**	**F**	**A**	**B**	**CD**
	4	**D**	**E**	**F**	**A**	**BC**
	5	**C**	**D**	**E**	**F**	**AB**
	6	**B**	**C**	**D**	**E**	**FA**
		semantic	**phonemic**	**image**	**graphemic**	
III	**1**	**A**	**B**	**C**	**D**	**EF**
	2	**F**	**A**	**B**	**C**	**DE**
	3	**E**	**F**	**A**	**B**	**CD**
	4	**D**	**E**	**F**	**A**	**BC**
	5	**C**	**D**	**E**	**F**	**AB**
	6	**B**	**C**	**D**	**E**	**FA**
		image	**graphemic**	**semantic**	**phonemic**	
IV	**1**	**A**	**B**	**C**	**D**	**EF**
	2	**F**	**A**	**B**	**C**	**DE**
	3	**E**	**F**	**A**	**B**	**CD**
	4	**D**	**E**	**F**	**A**	**BC**
	5	**C**	**D**	**E**	**F**	**AB**
	6	**B**	**C**	**D**	**E**	**FA**

Appendix 4.2 Word-Pairs List of Experiment 4

	High Associates (70% - 55 %)			Low Associates (6 % - 15 %)		
No	*Cue*	*Target*	*Association Strength*	*Cue*	*Target*	*Ass. strengt*
1	BLIZZARD	SNOW	70	TEETH	MOUTH	15
2	TADPOLE	FROG	69	STORM	WIND	15
3	SALOON	BAR	69	GUARD	SOLDIER	15
4	GIGGLE	LAUGH	69	CUTE	SWEET	15
5	CAPTAIN	SHIP	69	CROSS	CHURCH	15
6	LAD	BOY	68	COMPLEX	DIFFICULT	15
7	SPRINT	RUN	67	CHOOSE	PICK	15
8	SAUCER	CUP	67	TRAGIC	SAD	14
9	PRAM	BABY	67	SYSTEM	COMPUTER	14
10	MARGARINE	BUTTER	67	STRENGTH	MUSCLE	14
11	GRIME	DIRT	67	SKILL	ABILITY	14
12	ENVELOPE	LETTER	67	PILL	TABLET	14
13	DISCOVER	FIND	67	ORDEAL	TRIAL	14
14	CONVERSE	TALK	67	MUSIC	SOUND	14
15	CONCLUSION	END	67	MAGAZINE	PAPER	14
16	CAT	DOG	67	EXTEND	LENGTHEN	14
17	BRIDE	GROOM	67	CLEVER	INTELLIGENT	14
18	MEDIC	DOCTOR	66	BUTTERFLY	WINGS	14
19	LESS	MORE	66	BISCUIT	TEA	14
20	CHEF	COOK	66	UNSAVOURY	NASTY	13
21	STROLL	WALK	65	SUCCESS	FAILURE	13
22	PUN	JOKE	65	MOOD	HAPPY	13
23	VENOM	SNAKE	64	HATRED	LOVE	13
24	NEAR	FAR	64	DRILL	HOLE	13
25	COB	CORN	64	DESTRUCTION	BUILDING	13
26	ASSIST	HELP	64	CALM	WATER	13
27	UMBRELLA	RAIN	63	BIND	ROPE	13
28	MISLAY	LOSE	63	BALL	BAT	13
29	BROTH	SOUP	63	BAG	SACK	13
30	WEEP	CRY	62	WHALE	BONE	12
31	STING	BEE	62	WEAVE	CLOTH	12
32	QUID	POUND	62	SWEAR	OATH	12
33	KING	QUEEN	62	SUNSHINE	HOT	12
34	IMMEDIATE	NOW	62	STEADY	FIRM	12
35	WHITE	BLACK	62	SET	JELLY	12
36	TORSO	BODY	62	PROTECT	SURVIVE	12
37	FRAGRANCE	SMELL	62	OFFENCE	CRIME	12
38	GOOD	BAD	62	MARRY	WEDDING	12
39	BRANCH	TREE	62	HAT	CAP	12
40	HARE	RABBIT	61	GYMNAST	ATHLETE	12
41	AUNT	UNCLE	61	DEFENCE	ATTACK	12
42	TEAR	RIP	60	DEATH	GRAVE	12
43	NOVEL	BOOK	60	CRAFT	ART	12
44	NOTION	IDEA	60	CLUE	DETECTIVE	12
45	LANTERN	LIGHT	60	CHOICE	DECISION	12
46	FROCK	DRESS	60	BUMP	HEAD	12
47	DASHBOARD	CAR	60	BOWL	FRUIT	12
48	CONSUME	EAT	60	BLESS	PRIEST	12
49	CALF	COW	60	AMBASSADOR	COUNTRY	12
50	BLUNDER	MISTAKE	60	AMAZE	SURPRISE	12
51	ATLAS	MAP	60	TROUSERS	LEG	11
52	ARID	DRY	60	RULE	LAW	11

53	CART	HORSE	60	MEAN	STINGY	11
54	EXPLOSIVE	BOMB	59	DATE	TIME	11
55	DISAGREE	ARGUE	59	CUT	KNIFE	11
56	CREMATE	BURN	59	COOL	COLD	11
57	SISTER	BROTHER	59	SWORD	FIGHT	10
58	REFUND	MONEY	59	STRICT	SEVERE	10
59	TWIST	TURN	58	HORN	BLOW	10
60	LEFT	RIGHT	58	GLAMOUR	FASHION	10
61	TIMID	SHY	58	FISH	SEA	10
62	CARTON	MILK	58	EXPANSION	GROWTH	10
63	GROAN	MOAN	58	EXCITEMENT	FUN	10
64	DECKER	DOUBLE	58	ENGRAVE	CARVE	10
65	CIGAR	SMOKE	58	EMERGENCY	AMBULANCE	10
66	BELL	RING	58	DISCOUNT	CHEAP	10
67	LOST	FOUND	57	DIAMOND	JEWEL	10
68	WITTY	FUNNY	57	CRACK	BREAK	10
69	ESTUARY	RIVER	57	CONFINE	IMPRISON	10
70	HATCHET	AXE	57	AUDITION	ACT	10
71	LOFT	ATTIC	56	RESTORE	FIX	9
72	SOBER	DRUNK	56	REBUILD	CONSTRUCT	9
73	GLOBE	WORLD	56	OBNOXIOUS	HORRID	9
74	GLEAM	SHINE	56	MODERN	NEW	9
75	DISORDER	CHAOS	56	MAKE	CREATE	9
76	GRATER	CHEESE	56	CLUMSY	AWKWARD	9
77	DREAD	FEAR	56	CHILD	MOTHER	9
78	STUMBLE	FALL	56	BENT	CROOKED	9
79	SKINNY	THIN	56	BARON	KNIGHT	9
80	TOE	FOOT	55	HEDGEHOG	PRICKLY	8
81	LOCK	KEY	55	FREE	EASY	8
82	TANGERINE	ORANGE	55	CRISIS	DRAMA	7
83	MALLET	HAMMER	55	OBSCURE	STRANGE	6
84	CEREAL	BREAKFAST	55	GOD	HEAVEN	6
AVERAGE ASSOCIATION STRENGTH			**61**			**12**

Appendix 4.3 Participants' Data from Experiment 4

YOUNGER ADULTS GROUP (48 TOTAL)

L1=Graphemic, L2=Phonemic, L3=Semantic, L4=Image

Ss	*time*		*L1H*	*L1L*	*L2H*	*L2L*	*L3H*	*L3L*	*L4H*	*L4L*	*DH*	*DL*
S02S	150.15	Incid.	.50	.14	.86	.29	.79	.57	.71	.29	.64	.07
S04	128.97	Incid.	.50	.07	.79	.21	.50	.36	.57	.07	.71	.11
s06	178.55	Incid.	.71	.21	.64	.21	.93	.57	.71	.50	.71	.14
S08	103.30	Incid.	.71	.14	.71	.21	.43	.29	.79	.14	.43	.07
S10S	179.82	Incid.	.71	.14	.64	.07	.79	.29	.71	.50	.61	.21
s12	134.23	Incid.	.71	.21	.86	.14	.79	.36	.93	.07	.86	.07
S14S	119.60	Incid.	.64	.21	.79	.00	.86	.50	.86	.64	.68	.07
S16	188.42	Incid.	.79	.29	.64	.36	.86	.43	.86	.50	.57	.14
S18	91.50	Incid.	.64	.00	.57	.00	.86	.00	.93	.29	.46	.07
S20	133.90	Incid.	.50	.36	.71	.21	.86	.79	.93	.50	.64	.07
S22S	184.22	Incid.	.57	.29	.79	.29	.79	.14	.79	.21	.46	.04
s24	183.80	Incid.	.79	.21	.79	.50	.86	.57	.93	.57	.68	.21
s26b	150.58	Incid.	.86	.07	.71	.21	1.00	.50	.86	.50	.50	.14
S28	86.62	Incid.	.50	.14	.64	.00	.57	.29	.36	.00	.43	.14
S30	130.15	Incid.	.71	.00	.71	.36	.86	.57	.79	.07	.43	.11
s32	190.27	Incid.	.57	.14	.71	.29	.93	.50	1.00	.64	.75	.21
S34S	124.50	Incid.	.86	.07	.64	.14	.71	.36	.57	.43	.57	.07
s36	141.20	Incid.	.50	.07	.71	.14	.57	.57	.79	.36	.43	.11
S38	127.02	Incid.	.43	.00	.43	.14	.64	.29	.50	.43	.43	.07
S40	131.90	Incid.	.57	.29	.86	.14	.50	.21	.86	.43	.64	.18
s42	208.08	Incid.	.86	.29	.93	.29	.93	.57	.93	.57	.71	.14
s44	140.52	Incid.	.71	.21	.86	.14	.64	.43	.71	.29	.61	.07
s46	133.72	Incid.	.57	.14	.71	.21	.79	.43	.93	.36	.64	.14
s48	172.32	Incid.	.43	.07	.86	.36	.79	.36	.71	.64	.82	.14
S01	110.0	intent	.00	.00	.21	.00	.64	.57	.79	.57	.00	.00
s03	128.0	intent	.14	.00	.21	.14	1.0	.50	.79	.57	.00	.00
S05	127.8	intent	.36	.00	.43	.21	.93	.50	.79	.50	.04	.00
S07S	99.78	intent	.14	.07	.29	.00	.93	.86	.93	.79	.00	.00
S09S	152.9	intent	.29	.21	.43	.00	1.0	.36	1.00	.57	.14	.00
S11	140.2	intent	.00	.07	.64	.21	.93	.71	1.00	.71	.00	.00
S13	129.9	intent	.07	.00	.07	.00	.86	.79	.71	.79	.04	.00
S15S	108.6	intent	.07	.14	.29	.14	.71	.36	.71	.57	.04	.00
S17S	146.6	intent	.21	.00	.14	.07	.86	.79	1.00	.86	.00	.00
S19	121.0	intent	.57	.14	.14	.14	.93	.79	.57	.57	.00	.00
S21	95.67	intent	.00	.00	.21	.00	.86	.93	.79	.21	.00	.00
S23	138.1	intent	.21	.00	.36	.29	1.0	.71	.86	.71	.00	.00
S25	88.22	intent	.14	.00	.14	.14	.50	.36	.71	.43	.00	.00
S27	115.9	intent	.29	.07	.29	.07	.93	.71	.71	.43	.04	.00
s29	122.3	intent	.07	.07	.36	.00	1.0	.50	.71	.71	.04	.00
S31	163.6	intent	.21	.00	.50	.00	.86	.86	.93	.79	.00	.04
S33	65.40	intent	.07	.07	.21	.00	.43	.50	.71	.07	.00	.00
S35	200.4	intent	.14	.14	.36	.07	.71	.71	.57	.79	.00	.00
S37	169.0	intent	.14	.07	.64	.36	.93	.93	.86	.64	.00	.00
s39	166.7	intent	.21	.00	.57	.29	1.0	.79	.93	.93	.00	.00
S41	129.4	intent	.00	.00	.14	.00	.57	.50	.64	.36	.00	.00
S43	182.7	intent	.21	.07	.43	.14	.93	.86	.86	.64	.00	.07
S45	102.3	intent	.14	.00	.07	.21	.71	.36	.86	.36	.04	.00
S47	161.2	intent	.00	.00	.43	.14	1.0	.57	.86	.64	.00	.00

OLDER ADULTS GROUP (48 TOTAL)
L1=Graphemic, L2=Phonemic, L3=Semantic, L4=Image

Ss	*time*		*L1H*	*L1L*	*L2H*	*L2L*	*L3H*	*L3L*	*L4H*	*L4L*	*DH*	*DL*
s02o	145.53	Incid.	.64	.21	.86	.14	.79	.57	.79	.43	.75	.04
s04o	208.35	Incid.	.64	.29	.64	.00	.79	.29	.71	.14	.57	.04
s06o	155.93	Incid.	.57	.07	.57	.29	.79	.21	.43	.14	.61	.07
s08o	166.43	Incid.	.50	.14	.57	.00	.79	.29	.64	.21	.57	.11
s10o	236.60	Incid.	.79	.07	.86	.07	.71	.29	.86	.14	.54	.21
s12o	202.88	Incid.	.50	.07	.79	.07	.71	.29	1.00	.14	.79	.11
s14os	142.57	Incid.	.79	.07	.50	.29	.93	.71	.79	.36	.64	.11
s16o	177.27	Incid.	.57	.14	1.00	.21	.79	.36	.71	.36	.75	.04
s18o	132.20	Incid.	.79	.50	.71	.21	.79	.36	.86	.79	.64	.18
s20os	152.30	Incid.	.71	.14	.64	.29	.50	.36	.71	.21	.54	.18
s22o	126.67	Incid.	.43	.14	.57	.14	.43	.21	.71	.21	.54	.21
s24o	161.07	Incid.	.79	.29	.71	.29	.93	.36	.86	.07	.68	.32
s26o	193.53	Incid.	1.00	.21	.79	.29	.79	.29	.86	.29	.71	.11
s28o	167.27	Incid.	.86	.07	.71	.14	.93	.29	.79	.29	.68	.11
s30o	177.05	Incid.	.43	.29	.64	.14	.79	.14	.57	.14	.39	.00
s32o	257.33	Incid.	.64	.07	.50	.14	.57	.50	.64	.29	.54	.04
s34o	195.10	Incid.	.50	.00	.36	.07	.64	.07	.86	.14	.29	.14
s36o	149.23	Incid.	.86	.00	.86	.14	.79	.71	.86	.71	.64	.14
S38o	110.18	Incid.	.64	.07	.43	.14	.36	.00	.50	.14	.32	.04
S40o	145.48	Incid.	.50	.14	.64	.07	.86	.29	.86	.29	.71	.18
s42o	170.52	Incid.	.57	.14	.57	.29	.57	.29	.64	.14	.46	.18
s44o	137.07	Incid.	.64	.21	.50	.21	.64	.07	.64	.21	.68	.11
S46o	138.10	Incid.	.79	.29	.79	.07	.86	.29	.79	.14	.54	.18
s48o	115.05	Incid.	.64	.00	.93	.14	.64	.07	.57	.43	.64	.07
S01o	125.33	intent	.00	.14	.36	.00	.64	.50	.71	.36	.00	.00
s03o	189.12	intent	.07	.07	.00	.07	.64	.43	.64	.36	.04	.00
s05o	90.90	intent	.00	.00	.00	.00	.79	.29	.43	.36	.00	.00
s07o	144.03	intent	.07	.00	.43	.21	1.0	.71	1.0	.93	.00	.00
s09o	28.50	intent	.00	.00	.00	.00	.29	.14	.07	.14	.00	.00
s11o	135.35	intent	.00	.00	.21	.00	.86	.50	.93	.43	.00	.00
S13o	118.92	intent	.21	.07	.14	.14	1.0	.71	.93	.71	.00	.00
S15o	100.25	intent	.07	.07	.21	.07	1.0	.86	.79	.64	.00	.00
s17o	38.58	intent	.00	.00	.14	.00	.43	.21	.07	.21	.04	.00
s19o	132.50	intent	.00	.00	.29	.00	.43	.21	.43	.00	.00	.00
s21o	185.48	intent	.07	.07	.29	.07	.86	.79	1.0	.64	.00	.00
s23o	130.67	intent	.14	.00	.07	.00	.57	.21	.64	.29	.04	.00
s25o	175.23	intent	.29	.00	.36	.07	.79	.36	.71	.29	.29	.04
s27o	134.78	intent	.14	.00	.07	.00	.43	.07	.57	.00	.00	.00
s29o	101.12	intent	.00	.00	.07	.00	.57	.14	.43	.21	.07	.00
s31o	92.83	intent	.07	.00	.14	.00	.64	.36	.57	.29	.00	.00
s33o	103.95	intent	.00	.00	.00	.00	.43	.00	.86	.21	.00	.00
s35o	78.62	intent	.07	.00	.07	.00	.64	.64	.50	.14	.00	.00
s37o	132.80	intent	.14	.07	.21	.07	.29	.21	.36	.07	.14	.00
s39o	139.58	intent	.00	.00	.07	.00	.43	.29	.21	.14	.00	.00
s41o	147.15	intent	.14	.00	.14	.00	.64	.43	.79	.36	.00	.00
s43o	92.18	intent	.00	.00	.00	.00	.86	.57	.71	.21	.00	.00
s45o	109.22	intent	.00	.00	.14	.07	.79	.29	.86	.43	.00	.00
s47o	73.73	intent	.00	.00	.14	.00	.71	.07	.50	.29	.00	.00

Appendix 4.4 Item Analysis Data from Experiment 4

YOUNGER ADULTS GROUP (48 TOTAL)
Item Analysis (168 Words)

Low Associates: (84 word-pairs)

			Incidental					*Intentional*				
Cue	*Target*	*freq.*	*L1*	*L2*	*L3*	*L4*	*D*	*L1*	*L2*	*L3*	*L4*	*D*
god	heaven	6	.00	.00	.50	.50	.12	.00	.00	.75	1.00	.00
obscure	strange	6	.25	.25	.00	.25	.12	.00	.00	1.00	.50	.00
crisis	drama	7	.00	.00	.25	.00	.00	.00	.00	.40	.25	.00
free	easy	8	.00	.00	.25	.00	.00	.00	.00	1.00	.00	.00
hedgehog	prickly	8	.25	.75	.75	.50	.00	.33	.50	.50	.40	.00
baron	knight	9	.00	.25	.25	.00	.12	.00	.40	.50	1.00	.00
bent	crooked	9	.25	.25	.50	.25	.12	.00	.00	.50	.50	.00
child	mother	9	.00	.00	.50	.25	.12	.00	.00	1.00	.75	.00
clumsy	awkward	9	.00	.00	.25	.00	.00	.00	.00	.40	.50	.00
make	create	9	.00	.25	.25	.25	.00	.20	.25	.67	.25	.00
modern	new	9	.50	.50	.50	.75	.38	.00	.25	1.00	1.00	.00
obnoxious	horrid	9	.00	.00	.00	.00	.00	.00	.00	.25	.33	.00
rebuild	construct	9	.50	.50	.50	.25	.12	.00	.00	.75	.50	.00
restore	fix	9	.00	.00	.25	.25	.12	.00	.00	.00	.25	.00
audition	act	10	.00	.25	1.00	.50	.00	.00	.25	1.00	.25	.00
confine	imprison	10	.00	.00	.25	.25	.25	.00	.00	.33	.50	.00
crack	break	10	.25	.50	.50	.75	.12	.00	.00	.75	.60	.12
diamond	jewel	10	.00	.00	.75	.00	.00	.00	.20	1.00	1.00	.00
discount	cheap	10	.25	.25	.25	.25	.00	.00	.00	1.00	.75	.00
emergency	ambulance	10	.25	.25	.50	.50	.25	.25	.25	.75	.75	.00
engrave	carve	10	.25	.50	.50	.25	.12	.00	.25	1.00	.75	.00
excitement	fun	10	.00	.00	.25	.75	.12	.00	.00	1.00	.50	.00
expansion	growth	10	.00	.50	.25	.25	.00	.00	.00	.50	.60	.00
fish	sea	10	.00	.00	.75	.50	.00	.00	.00	.50	.67	.00
glamour	fashion	10	.25	.50	.25	.75	.12	.00	.00	1.00	1.00	.00
horn	blow	10	.00	.25	.50	.50	.00	.00	.00	.50	.25	.00
strict	severe	10	.00	.00	.00	.25	.00	.00	.00	.20	.50	.00
sword	fight	10	.50	.25	.25	.25	.12	.00	.25	.33	.25	.00
cool	cold	11	.00	.50	.25	.75	.12	.67	.50	1.00	.60	.00
cut	knife	11	.50	.00	.50	.25	.12	.00	.00	.50	1.00	.00
date	time	11	.00	.50	.25	.50	.12	.00	.00	1.00	1.00	.00
mean	stingy	11	.25	.25	.25	.25	.12	.00	.00	.75	.25	.00
rule	law	11	.00	.00	.50	.50	.12	.00	.00	.60	.50	.00
trousers	leg	11	.25	.25	.50	.25	.12	.20	.00	1.00	1.00	.00
amaze	surprise	12	.25	.00	.25	.50	.12	.00	.00	.75	.00	.12
ambassador	country	12	.25	.00	.75	.75	.50	.00	.20	.75	1.00	.00
bless	priest	12	.00	.50	.00	.25	.12	.25	.33	.75	1.00	.00
bowl	fruit	12	.25	.25	.50	.75	.00	.00	.00	.25	.75	.00
bump	head	12	.25	.50	.50	.00	.50	.00	.25	.60	1.00	.00
choice	decision	12	.25	.00	.00	.50	.00	.00	.00	.33	.50	.00
clue	detective	12	.00	.25	.00	.75	.12	.00	.00	.75	.40	.00
craft	art	12	.00	.00	.75	.50	.12	.00	.00	.50	1.00	.00
death	grave	12	.00	.00	.25	.50	.00	.00	.33	.50	.75	.00
defence	attack	12	.25	.25	.25	.75	.00	.00	.00	.75	.50	.00
gymnast	athlete	12	.25	.50	.25	.50	.12	.00	.75	.80	1.00	.00
hat	cap	12	.00	.25	.50	.25	.12	.20	.00	1.00	.75	.00
marry	wedding	12	.25	.50	.75	.50	.12	.00	.00	1.00	1.00	.00
offence	crime	12	.00	.25	.50	.75	.00	.00	.00	.75	.67	.00
protect	survive	12	.00	.00	.00	.00	.00	.00	.00	.25	.00	.00
set	jelly	12	.00	.00	.25	.25	.00	.00	.00	.00	.00	.00
steady	firm	12	.25	.00	.00	.25	.00	.00	.00	.00	.25	.00
sunshine	hot	12	.00	.25	.25	.00	.00	.00	.00	1.00	.50	.00
swear	oath	12	.00	.25	.25	.25	.00	.00	.25	1.00	.60	.00
weave	cloth	12	.00	.25	.25	.00	.12	.00	.20	.25	.33	.00
whale	bone	12	.00	.25	.50	.50	.00	.00	.00	.75	.75	.00
bag	sack	13	.25	.25	.75	.75	.00	.00	.00	.75	.50	.00
ball	bat	13	.00	.00	.50	.50	.50	.00	.25	.60	.75	.00
bind	rope	13	.00	.00	.00	.50	.00	.00	.00	.33	.00	.00
calm	water	13	.00	.00	.00	.25	.00	.00	.00	.50	.40	.00
destruction	building	13	.00	.00	.25	.00	.00	.00	.00	.50	.33	.00

drill	hole	13	.25	.25	.75	.75	.50	.25	.00	.75	.75	.00
hatred	love	13	.25	.25	1.00	.50	.12	.25	.25	.75	.50	.00
mood	happy	13	.25	.00	.50	.25	.00	.00	.25	.80	.50	.00
success	failure	13	.50	.50	.75	.50	.12	.00	.00	.67	.50	.12
unsavoury	nasty	13	.00	.00	.00	.25	.12	.00	.25	.25	.40	.00
biscuit	tea	14	.50	.25	.75	.50	.38	.00	.20	.75	1.00	.00
butterfly	wings	14	.50	.00	.25	1.00	.00	.25	.33	1.00	1.00	.00
clever	intelligent	14	.75	.50	.50	.25	.12	.25	.25	1.00	.50	.00
extend	lengthen	14	.25	.25	.50	.50	.00	.00	.00	.60	.50	.00
magazine	paper	14	.00	.00	.25	.25	.12	.00	.25	1.00	.75	.00
music	sound	14	.00	.00	.75	.25	.00	.00	.00	1.00	1.00	.00
ordeal	trial	14	.00	.25	.75	.00	.12	.00	.00	.00	.33	.00
pill	tablet	14	.50	.50	.50	.50	.50	.00	.00	.75	1.00	.00
skill	ability	14	.25	.00	.50	.00	.12	.00	.00	.50	.25	.00
strength	muscle	14	.00	.00	.25	.00	.12	.00	.00	.40	.50	.00
system	computer	14	.50	.75	.75	.75	.38	.60	.25	.67	.75	.00
tragic	sad	14	.00	.25	.50	.50	.25	.00	.00	.50	.20	.00
choose	pick	15	.25	.00	.75	.25	.12	.00	.00	.25	.33	.00
complex	difficult	15	.25	.50	.50	.50	.25	.00	.00	.75	1.00	.00
cross	church	15	.00	.00	.75	.25	.00	.00	.00	.75	.50	.00
cute	sweet	15	.50	.25	.75	.50	.38	.25	.50	.80	.50	.00
guard	soldier	15	.00	.75	.75	.75	.00	.00	.25	.67	1.00	.00
storm	wind	15	.25	.25	.00	.00	.00	.00	.25	.50	1.00	.00
teeth	mouth	15	.50	.00	.75	.50	.50	.00	.40	1.00	1.00	.00

High Associates

			Incidental					*Intentional*				
Cue	*Target*	*freq.*	*L1*	*L2*	*L3*	*L4*	*D*	*L1*	*L2*	*L3*	*L4*	*D*
cereal	breakfast	55	.50	.50	.25	.50	.38	.50	.00	1.00	1.00	.00
lock	key	55	.75	1.00	1.00	.75	.88	.20	.33	1.00	1.00	.11
mallet	hammer	55	.50	.75	.75	.75	.88	.00	.50	.80	.50	.14
tangerine	orange	55	1.00	.75	1.00	1.00	.75	.00	.75	1.00	1.00	.00
toe	foot	55	.75	.50	1.00	.75	.62	.00	.40	1.00	1.00	.00
disorder	chaos	56	.25	.50	.25	.75	.25	.00	.67	.33	.25	.00
dread	fear	56	.75	.50	.50	.50	.12	.00	.00	.75	.75	.00
gleam	shine	56	.50	.75	.75	1.00	.38	.00	.00	.50	.80	.00
globe	world	56	.25	.50	1.00	.75	.62	.00	.20	.75	1.00	.12
grater	cheese	56	.75	1.00	1.00	1.00	.62	.50	.25	.80	1.00	.00
loft	attic	56	.25	.25	.75	.75	.50	.00	.20	1.00	.75	.00
skinny	thin	56	.25	.50	.50	1.00	.62	.33	.20	1.00	1.00	.00
sober	drunk	56	.75	1.00	1.00	1.00	.62	.20	1.00	1.00	1.00	.00
stumble	fall	56	.50	1.00	.75	1.00	.75	.00	.00	.75	.75	.00
estuary	river	57	.25	.50	.75	.75	.62	.00	.25	.67	1.00	.00
hatchet	axe	57	.00	.00	.25	.25	.25	.00	.25	.80	.50	.00
lost	found	57	.50	.75	.75	.75	.75	.33	.40	.50	1.00	.00
witty	funny	57	.25	.75	.25	.50	.50	.00	.25	.67	.83	.00
attempt	try	58	1.00	.50	1.00	1.00	1.00	.50	.25	.83	1.00	.00
bell	ring	58	.50	.25	.25	1.00	.75	.00	.00	1.00	1.00	.00
carton	milk	58	.75	1.00	.75	1.00	.38	.33	.00	.67	1.00	.00
cigar	smoke	58	.25	.50	.50	1.00	.38	.00	.25	1.00	.50	.00
groan	moan	58	1.00	.75	.75	1.00	.25	.20	1.00	1.00	.50	.00
left	right	58	.75	1.00	.75	1.00	1.00	.00	.33	.75	1.00	.00
timid	shy	58	.75	.75	1.00	.75	.75	.00	.40	.75	.67	.12
twist	turn	58	.50	.75	.25	.75	.62	.25	.00	1.00	1.00	.12
cremate	burn	59	1.00	1.00	.25	.25	.50	.33	.25	1.00	.83	.00
disagree	argue	59	.00	.00	1.00	.50	.12	.00	.00	.50	.67	.00
explosive	bomb	59	.25	.50	.50	1.00	.12	.00	.33	1.00	1.00	.00
refund	money	59	.50	.75	.25	.75	.88	.00	.25	.80	.33	.00
sister	brother	59	1.00	1.00	1.00	.75	.50	.40	1.00	.67	1.00	.00
arid	dry	60	1.00	.50	1.00	1.00	.38	.50	.50	1.00	1.00	.00
atlas	map	60	.00	.50	.25	.50	.25	.00	.33	.67	.75	.00
blunder	mistake	60	.50	.50	.50	.50	.50	.00	.00	1.00	.50	.00
calf	cow	60	.50	.75	.75	.75	.50	.00	.33	1.00	1.00	.00
cart	horse	60	.75	.50	1.00	.75	.38	.00	.40	1.00	.50	.00
consume	eat	60	1.00	.75	.75	.75	.75	.25	.67	.75	1.00	.00
dashboard	car	60	1.00	1.00	.75	1.00	1.00	.20	.25	.75	.75	.00
frock	dress	60	.75	.75	1.00	1.00	.75	.00	.50	.83	.67	.00
lantern	light	60	.50	1.00	.75	.75	.62	.00	.00	1.00	1.00	.00
notion	idea	60	.00	.50	.25	.50	.62	.00	.25	1.00	.17	.00
novel	book	60	.75	.75	.75	1.00	.88	.33	.80	.75	1.00	.00
up	down	60	1.00	.75	1.00	1.00	.88	.50	.00	1.00	1.00	.00
aunt	uncle	61	1.00	1.00	.75	1.00	1.00	.25	1.00	1.00	1.00	.00

hare	rabbit	61	.75	.25	.50	.75	.62	.00	.25	1.00	.75	.00
branch	tree	62	.50	1.00	.50	1.00	1.00	.20	.33	1.00	1.00	.00
fragrance	smell	62	1.00	1.00	.75	.25	.38	.33	.20	.50	1.00	.00
good	bad	62	1.00	1.00	.75	.50	.88	.00	.20	1.00	.80	.00
immediate	now	62	.75	.75	1.00	.75	.62	.00	.25	1.00	.67	.00
king	queen	62	.75	.75	1.00	.75	1.00	.50	.67	.67	1.00	.00
quid	pound	62	.50	.75	.50	.75	.38	.25	.25	1.00	.80	.00
sting	bee	62	.50	1.00	.75	.50	.75	.33	.40	1.00	.67	.00
torso	body	62	.50	.25	1.00	.50	.50	.25	.00	.80	1.00	.00
weep	cry	62	1.00	1.00	1.00	1.00	1.00	.40	.33	1.00	1.00	.00
white	black	62	.50	.75	.75	1.00	.38	.75	.25	.80	1.00	.14
broth	soup	63	.50	1.00	.75	.75	.50	.25	.60	1.00	.25	.00
mislay	lose	63	.75	.25	.75	.25	.38	.00	.25	.60	.67	.00
umbrella	rain	63	.50	1.00	1.00	1.00	.50	.20	.00	.67	.75	.00
assist	help	64	1.00	1.00	1.00	1.00	.75	.00	.25	.67	.67	.00
cob	corn	64	.50	1.00	.75	1.00	.62	.33	.17	.25	1.00	.12
near	far	64	.75	.75	1.00	1.00	.62	.00	.00	.75	1.00	.00
venom	snake	64	.50	.75	1.00	1.00	.62	.25	.25	.75	.60	.00
pun	joke	65	.50	.75	1.00	.25	.50	.25	.60	.60	.67	.00
stroll	walk	65	.75	.75	.50	1.00	.62	.20	.00	.75	1.00	.00
chef	cook	66	.75	1.00	1.00	.75	.38	.00	.25	1.00	1.00	.00
less	more	66	1.00	.75	1.00	1.00	.88	.33	.60	1.00	.67	.11
medic	doctor	66	.50	.75	.75	.75	.62	.25	.00	1.00	.75	.00
bride	groom	67	1.00	.50	1.00	1.00	.62	.25	.75	1.00	1.00	.00
cat	dog	67	1.00	.75	1.00	.75	.50	.00	.75	1.00	1.00	.14
conclusion	end	67	.25	.75	1.00	1.00	.62	.00	.00	.67	.50	.00
converse	talk	67	.75	.75	.50	.50	.50	.00	.25	.75	.60	.00
discover	find	67	.50	.75	.75	.75	.88	.25	.20	.50	.00	.12
envelope	letter	67	.50	.50	.75	1.00	.62	.00	.00	1.00	1.00	.00
grime	dirt	67	.50	.50	1.00	.75	.12	.25	.00	.80	.75	.00
margarine	butter	67	.75	.75	1.00	1.00	.75	.40	.75	1.00	1.00	.00
pram	baby	67	.75	.75	.75	.75	.62	.00	.67	.67	1.00	.00
saucer	cup	67	.75	.75	1.00	.50	.88	.33	.25	1.00	.80	00
sprint	run	67	1.00	.75	.75	.75	.75	.33	.00	1.00	1.00	.00
lad	boy	68	1.00	.75	.50	.75	.62	.25	.75	1.00	1.00	.00
captain	ship	69	.75	1.00	.50	.75	.38	.00	.50	.75	1.00	.00
giggle	laugh	69	.75	1.00	1.00	.75	.50	.25	.25	1.00	.67	.00
saloon	bar	69	.75	1.00	1.00	.75	.62	.00	.00	1.00	.75	.00
tadpole	frog	69	.75	1.00	1.00	.75	.75	.00	.50	.67	1.00	.00
blizzard	snow	70	.50	1.00	1.00	.50	.50	.00	.33	1.00	1.00	.00

OLDER ADULTS GROUP (48 TOTAL)

Low Associates

			Incidental					*Intentional*				
Cue	*Target*	*Ass.*	*L1*	*L2*	*L3*	*L4*	*D*	*L1*	*L2*	*L3*	*L4*	*D*
God	heaven	6	.00	.25	.25	.75	.00	.00	.00	.50	.00	.00
Obscure	strange	6	.00	.00	.25	.00	.00	.00	.00	.00	.00	.00
Crisis	drama	7	.00	.00	.25	.00	.00	.00	.25	.00	.00	.00
free	easy	8	.25	.25	.25	.00	.00	.00	.00	.00	.00	.00
hedgehog	prickly	8	.25	.00	.50	.75	.12	.00	.00	.75	.50	.00
baron	knight	9	.00	.50	1.00	.25	.25	.33	.20	.33	1.00	.00
bent	crooked	9	.25	.50	.25	.75	.50	.00	.33	.25	.00	.00
child	mother	9	.00	.25	.50	.25	.00	.00	.00	.33	.25	.00
clumsy	awkward	9	.25	.25	.75	.50	.12	.00	.00	.33	.75	.00
make	create	9	.00	.25	.25	.00	.12	.00	.00	.50	.50	.00
modern	new	9	.00	.00	.50	.75	.25	.25	.33	1.00	.25	.00
obnoxious	horrid	9	.00	.00	.50	.50	.00	.00	.00	.00	.50	.00
rebuild	construct	9	.25	.00	.50	.25	.00	.00	.00	.50	.00	.00
restore	fix	9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
audition	act	10	.00	.00	.00	.25	.00	.00	.00	.67	.00	.00
confine	imprison	10	.00	.25	.00	.25	.12	.00	.00	.50	.50	.00
crack	break	10	.00	.00	.50	.50	.00	.00	.00	.25	.25	.00
diamond	jewel	10	.50	.25	.50	.25	.12	.00	.20	.33	.50	.00
discount	cheap	10	.00	.25	.00	.50	.00	.00	.33	.00	.33	.00
emergency	ambulance	10	.00	.00	.25	.25	.00	.00	.00	.67	.50	.00
engrave	carve	10	.25	.00	.00	.50	.12	.00	.00	.67	.00	.00
excitement	fun	10	.00	.00	.00	.00	.12	.00	.00	.25	.50	.00
expansion	growth	10	.00	.25	.25	.00	.00	.00	.00	.00	.00	.00
fish	sea	10	.25	.25	.00	.00	.00	.00	.00	.33	.50	.00
glamour	fashion	10	.00	.00	.00	.25	.00	.00	.00	.75	.00	.00
horn	blow	10	.00	.50	.25	.25	.00	.00	.00	.33	.25	.00
strict	severe	10	.25	.00	.75	.25	.25	.00	.00	.67	.50	.00
sword	fight	10	.00	.00	.00	.00	.00	.00	.00	.25	.50	.00
cool	cold	11	.25	.25	.25	.50	.00	.00	.00	1.00	.25	.00
cut	knife	11	.00	.00	.00	.00	.25	.00	.00	.33	.25	.00
date	time	11	.50	.00	.25	.25	.00	.00	.00	.50	.00	.00
mean	stingy	11	.50	.25	.25	.00	.12	.25	.00	1.00	.50	.00
rule	law	11	.50	.00	.50	.50	.00	.00	.00	.67	.50	.00
trousers	leg	11	.00	.00	.00	.25	.00	.25	.00	.75	.50	.00
amaze	surprise	12	.50	.50	.50	.75	.62	.00	.00	.25	.50	.00
ambassador	country	12	.50	.25	.50	.25	.25	.00	.00	.33	.75	.00
bless	priest	12	.00	.00	.25	.25	.00	.00	.00	.50	.00	.00
bowl	fruit	12	.00	.25	.25	.50	.12	.00	.00	.33	.50	.00
bump	head	12	.25	.00	.00	.00	.00	.00	.00	.33	.00	.00
choice	decision	12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
clue	detective	12	.00	.25	.75	.00	.12	.00	.00	.25	.75	.00
craft	art	12	.25	.25	.25	.00	.38	.00	.00	.67	.50	.00
death	grave	12	.00	.00	.00	.00	.00	.00	.00	.50	.00	.00
defence	attack	12	.25	.25	.25	.50	.12	.00	.00	.67	.25	.00
gymnast	athlete	12	.75	.00	.50	.50	.62	.00	.00	.67	.75	.00
hat	cap	12	.00	.50	.25	.50	.00	.00	.25	.75	1.00	.00
marry	wedding	12	.25	.50	.50	.00	.12	.00	.00	.75	.75	.00
offence	crime	12	.25	.25	.25	.25	.25	.00	.20	.33	.50	.00
protect	survive	12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
set	jelly	12	.25	.25	.75	.25	.00	.00	.00	.00	.25	.00
steady	firm	12	.00	.00	.25	.50	.00	.00	.00	.00	.25	.00
sunshine	hot	12	.00	.00	.00	.25	.00	.00	.00	.50	.00	.00
swear	oath	12	.00	.00	.50	.25	.25	.00	.00	.50	.50	.00
weave	cloth	12	.25	.25	.50	.25	.12	.00	.00	.33	.75	.00
whale	bone	12	.00	.00	.00	.25	.00	.25	.00	.50	.67	.00
bag	sack	13	.00	.25	.50	.00	.00	.00	.00	.33	.25	.00
ball	bat	13	.75	.50	.75	.50	.25	.00	.00	.67	.50	.00
bind	rope	13	.00	.00	.25	.00	.00	.00	.00	.25	.50	.00
calm	water	13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
destruction	building	13	.00	.00	.00	.00	.00	.00	.00	.33	.00	.00
drill	hole	13	.25	.00	.25	.25	.50	.00	.00	.25	.00	.00
hatred	love	13	.25	.00	.25	.00	.00	.00	.00	.33	.00	.00
mood	happy	13	.00	.25	.50	.50	.12	.00	.00	.00	.00	.00
success	failure	13	.00	.25	.75	.25	.62	.00	.00	.25	.00	.00

unsavoury	nasty	13	.00	.25	.50	.25	.25	.00	.00	.00	.00	.00
biscuit	tea	14	.00	.00	.25	.25	.25	.00	.00	1.00	.25	.00
butterfly	wings	14	.00	.25	.25	.25	.00	.00	.33	.50	.67	.00
clever	intelligent	14	.25	.00	.25	.25	.25	.00	.00	.67	.25	.00
extend	lengthen	14	.00	.75	.50	1.00	.12	.00	.00	.33	.50	.00
magazine	paper	14	.25	.25	.25	.25	.12	.00	.00	.75	.00	.00
music	sound	14	.50	.50	.75	.00	.12	.00	.00	.25	.00	.00
ordeal	trial	14	.50	.25	.25	.50	.00	.00	.00	.00	.25	.00
pill	tablet	14	.50	.00	.50	1.00	.25	.00	.00	.75	.67	.00
skill	ability	14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
strength	muscle	14	.25	.25	.25	.00	.00	.00	.00	.00	.25	.00
System	computer	14	.25	.00	.25	.25	.00	.00	.00	.25	.00	.00
Tragic	sad	14	.25	.50	1.00	.50	.62	.25	.00	.25	.75	.00
Choose	pick	15	.50	.25	.25	.25	.25	.00	.00	.00	.25	.00
Complex	difficult	15	.25	.25	.25	.50	.25	.00	.33	.50	.00	.14
Cross	church	15	.00	.00	.00	.00	.00	.00	.00	.33	.50	.00
Cute	sweet	15	.00	.00	.50	.50	.00	.00	.00	.67	.75	.00
Guard	soldier	15	.00	.00	.25	.25	.12	.00	.00	.50	.50	.00
Storm	wind	15	.00	.00	.25	.00	.00	.00	.00	.50	.25	.00
Teeth	mouth	15	.25	.75	.00	.25	.50	.33	.00	.67	.50	.00

High Associates

			Incidental					*Intentional*				
	Target	*Ass.*	*L1*	*L2*	*L3*	*L4*	*D*	*L1*	*L2*	*L3*	*L4*	*D*
Cereal	breakfast	55	.25	.50	.75	.75	.25	.00	.00	.75	.33	.00
Lock	key	55	.75	1.00	.75	.75	.50	.00	.25	.50	1.00	.00
Mallet	hammer	55	1.00	.50	.75	.75	1.00	.25	.00	1.00	1.00	.00
Tangerine	orange	55	.75	.50	.50	1.00	.62	.00	.50	1.00	.75	.00
Toe	foot	55	.50	.50	.75	1.00	.50	.00	.00	.75	.50	.00
disorder	chaos	56	.00	.25	.25	.75	.25	.00	.00	.25	.50	.00
dread	fear	56	.50	1.00	1.00	.75	.75	.25	.50	.33	.50	.12
gleam	shine	56	.25	.25	.50	.50	.38	.00	.00	.50	.50	.00
globe	world	56	.50	.50	.25	.50	.50	.00	.00	.33	.75	.00
grater	cheese	56	.50	.75	.75	.50	.62	.00	.00	.33	.50	.00
loft	attic	56	.50	1.00	.25	.75	.38	.00	.00	.33	1.00	.00
skinny	thin	56	.75	.75	1.00	.50	.75	.00	.40	.33	.75	.00
sober	drunk	56	.75	.50	.50	.75	.38	.00	.00	1.00	.33	.14
stumble	fall	56	.50	1.00	.75	.75	.62	.00	.00	.25	.00	.14
estuary	river	57	1.00	1.00	1.00	.75	.75	.50	.00	.50	1.00	.00
hatchet	axe	57	.50	.00	.50	1.00	.38	.00	.00	.67	1.00	.00
lost	found	57	1.00	.75	.50	.50	.62	.00	.00	.00	.75	.00
witty	funny	57	.00	.00	.75	.50	.25	.00	.00	.50	.25	.00
attempt	try	58	1.00	.75	.75	1.00	.75	.50	.25	.67	.50	.00
bell	ring	58	.50	.75	.50	.75	.62	.00	.00	1.00	.00	.00
carton	milk	58	.00	.25	.25	.50	.12	.00	.00	.25	.25	.00
cigar	smoke	58	.25	.75	.50	.75	.12	.00	.00	1.00	.50	.00
groan	moan	58	.75	.50	.00	.75	.50	.25	.50	.50	.00	.00
left	right	58	1.00	1.00	.75	.75	.88	.25	.33	.75	.00	.14
timid	shy	58	.00	.50	1.00	.75	.38	.00	.40	.67	1.00	.00
twist	turn	58	.75	.50	1.00	.75	.88	.00	.00	.67	.25	.00
cremate	burn	59	.25	.75	.75	.50	.50	.00	.00	.75	.50	.00
disagree	argue	59	.25	.25	.50	.75	.12	.00	.20	.33	.25	.00
explosive	bomb	59	.00	.50	.00	.75	.25	.00	.33	.50	.33	.00
refund	money	59	.75	.25	.25	.25	.12	.00	.00	.67	.50	.00
sister	brother	59	.75	.75	.75	1.00	.88	.00	.25	.75	1.00	.00
arid	dry	60	.75	.50	.50	.75	.62	.00	.25	.67	1.00	.00
atlas	map	60	.25	.75	.00	.75	.25	.50	.25	.50	.50	.00
blunder	mistake	60	.25	1.00	1.00	.25	.62	.00	.00	.50	.50	.00
calf	cow	60	1.00	.50	.50	.75	.62	.00	.20	1.00	1.00	.00
cart	horse	60	.75	.75	.75	1.00	.75	.00	.00	.33	.50	.12
consume	eat	60	.75	1.00	1.00	1.00	1.00	.00	.67	1.00	.33	.14
dashboard	car	60	.75	1.00	1.00	.75	.75	.00	.00	.67	1.00	.00
frock	dress	60	.75	.50	.75	.50	.88	.00	.25	.67	1.00	.00
lantern	light	60	1.00	.75	.75	.75	.75	.00	.00	.75	.50	.00
notion	idea	60	1.00	1.00	1.00	.75	.88	.25	.00	.25	1.00	.00
novel	book	60	1.00	.75	.50	.75	.75	.00	.00	1.00	.50	.00
up	down	60	1.00	1.00	.75	1.00	.88	.00	.33	1.00	.00	.29
aunt	uncle	61	.50	.50	1.00	1.00	.62	.00	.00	1.00	1.00	.00
hare	rabbit	61	1.00	.50	.75	1.00	.38	.50	.25	1.00	.75	.00
branch	tree	62	.75	1.00	1.00	.50	.62	.00	.00	1.00	.50	.14
fragrance	smell	62	.25	.00	.75	.25	.38	.00	.20	.33	.75	.00
good	bad	62	.75	1.00	1.00	1.00	.50	.00	.00	.00	.50	.00

immediate	now	62	.75	1.00	.75	.50	.38	.00	.00	.33	.50	.00
king	queen	62	1.00	.75	.75	1.00	.88	.25	.25	1.00	1.00	.00
quid	pound	62	.75	.75	1.00	.50	.38	.00	.33	1.00	1.00	.00
sting	bee	62	.50	.75	.25	.75	.25	.00	.00	1.00	.25	.00
torso	body	62	.75	1.00	.75	1.00	.75	.00	.33	.75	.00	.14
weep	cry	62	.75	.75	1.00	1.00	1.00	.50	.67	.75	.00	.14
white	black	62	.50	.75	.75	.50	1.00	.00	.00	1.00	1.00	.00
broth	soup	63	.75	1.00	1.00	1.00	.88	.00	.00	.67	.75	.12
mislay	lose	63	1.00	.50	1.00	1.00	.62	.00	.00	.67	.50	.00
umbrella	rain	63	1.00	.75	.75	.50	.50	.00	.00	1.00	.50	.00
assist	help	64	.75	1.00	1.00	.75	.75	.25	.00	.25	.75	.00
cob	corn	64	.50	.50	.50	.50	.25	.00	.00	1.00	.50	.00
near	far	64	.75	.75	.75	.50	.62	.00	.00	.25	.00	.00
venom	snake	64	.25	.50	.75	.75	.38	.00	.00	.67	.75	.00
pun	joke	65	.25	.25	.75	1.00	.62	.00	.00	.33	1.00	.00
stroll	walk	65	.75	.50	.75	1.00	62	.50	.50	.75	.50	.29
chef	cook	66	1.00	1.00	1.00	1.00	.62	.25	.33	.75	1.00	.00
less	more	66	.75	.75	1.00	.25	.75	.00	.00	.00	.50	.00
medic	doctor	66	.75	.75	.75	1.00	.75	.00	.33	.75	.33	.00
bride	groom	67	.50	.50	1.00	1.00	.50	.00	.00	1.00	.75	.12
cat	dog	67	.75	.75	1.00	.25	.88	.50	.50	.67	.75	.00
conclusion	end	67	1.00	1.00	.75	1.00	.75	.25	.00	.50	.50	.00
converse	talk	67	.25	.25	.50	.25	.25	.00	.00	.50	.50	.00
discover	find	67	1.00	.50	1.00	.75	.62	.00	.20	.33	.75	.00
envelope	letter	67	.50	.50	.50	.50	.75	.00	.00	.75	.00	.00
grime	dirt	67	1.00	1.00	1.00	.75	.75	.00	.50	.67	.75	.12
margarine	butter	67	1.00	1.00	.75	.75	.75	.00	.00	1.00	.75	.00
pram	baby	67	1.00	.75	1.00	1.00	.50	.00	.25	.50	.50	.00
saucer	cup	67	1.00	1.00	1.00	1.00	1.00	.00	.33	.75	1.00	.00
sprint	run	67	.75	.75	.75	1.00	.75	.00	.00	.67	.50	.00
lad	boy	68	.25	.50	1.00	.75	.62	.00	.33	.75	.00	.00
captain	ship	69	.75	.75	1.00	.75	.25	.00	.00	.67	.75	.00
giggle	laugh	69	1.00	.50	1.00	1.00	.62	.00	.50	1.00	.75	.12
saloon	bar	69	.75	.50	.25	.75	.50	.00	.50	.50	1.00	.00
tadpole	frog	69	.75	.75	.75	.50	.62	.00	.00	.75	1.00	.00
blizzard	snow	70	.75	.75	.75	.50	.75	.00	.00	1.00	.75	.00

Appendix 4.5. Table 4.1A

TABLE 4.1A

MEAN PROPORTIONS AND STANDARD ERROR (SE) OF CONCEPTUAL PRIMING (UNSTUDIED BASELINE SUBTRACTED) IN THE INCIDENTAL TEST AS A FUNCTION OF AGE, DEPTH OF PROCESSING AND ASSOCIATION STRENGTH.

	Studied							
Association	*Graphemic*		*Phonemic*		*Semantic*		*Image*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
				Incidental Test				
Younger adults								
High	.04	.04	.13	.02	.16	.03	.18	.03
Low	.04	.02	.09	.02	.30	.04	.26	.04
Older Adults								
High	.07	.03	.08	.03	.13	.03	.14	.03
Low	.03	.03	.04	.02	.18	.04	.15	.04

Appendix 4.6. 2x2x4 mixed ANOVA from Experiment 4

2x2x4 mixed factorial design ANOVA with age (young vs. old) as the between participant factor and with association strength (high vs. low) and depth of processing (graphemic,phonemic,semantic,image) as within participants factors, was carried out for the incidental and intentional test on proportionalised data.

Incidental test:

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	9.47	46	.21		
AGE	.30	1	.30	1.45	.235

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	11.77	138	.09		
DOP	4.91	3	1.64	19.20	.000
AGE BY DOP	.44	3	.15	1.73	.163

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	8.20	46	.18		
ASSOC	.93	1	.93	5.22	.027
AGE BY ASSOC	.09	1	.09	.52	.476

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	10.72	138	.08		
DOP BY ASSOC	.54	3	.18	2.30	.080
AGE BY DOP BY ASSOC	.12	3	.04	.53	.663

Intentional test

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	4.44	46	.10		
AGE	2.63	1	2.63	27.26	.000

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	3.54	138	.03		
DOP	24.62	3	8.21	320.22	.000
AGE BY DOP	.52	3	.17	6.78	.000

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	.56	46	.01		
ASSOC	2.78	1	2.78	226.86	.000
AGE BY ASSOC	.00	1	.00	.22	.639

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	1.80	138	.01		
DOP BY ASSOC	.55	3	.18	13.96	.000
AGE BY DOP BY ASSOC	.16	3	.05	4.21	.007

Appendix to Chapter 5

Appendix 5.1 Design of Experiment 5a and 5b

Tot no. Of word-pairs = 120

Word-pairs which constitute a phrase = 60
Word-pairs of Low association strength = 60

Four lists of words: A,B,C,D

Each list of 30 word-pairs has 15 word-pairs which constitute a phrase, and 15 with matched low association strength

Study list: Target word-pairs = 60 Distractor word-pairs = 60

Design: (The same design is repeated for incidental, intentional and inclusion retrieval conditions)

		phonemic	semantic	distractors
I	1	A	B	CD
	2	C	D	AB
	3	B	A	CD
	4	D	C	AB
		semantic	phonemic	distractor
II	1	A	B	CD
	2	C	D	AB
	3	B	A	CD
	4	D	C	AB

Appendix 5.2, Word-Pairs List of Experiments 5a,5b and 6

	Two-word phrases			Low associates		
	Cue	Target	Assoc. strengh	Cue	Target	Assoc. strengh
1	MAGIC	BOX	9	BARON	KNIGHT	9
2	MEMORY	LOSS	9	GREEK	LATIN	9
3	SHOP	FRONT	9	SHARE	GIVE	9
4	BUSINESS	MAN	10	EXCITEMENT	FUN	10
5	GAS	FIRE	10	STRICT	SEVERE	10
6	POT	PLANT	10	TABLECLOTH	CHECK	10
7	BABY	FACE	11	STEADY	FIRM	11
8	TOOTH	BRUSH	11	GATE	FENCE	11
9	EAR	RING	12	AUTHORITY	GOVERNMENT	12
10	LEATHER	BELT	12	DEFENCE	ATTACK	12
11	RUN	AWAY	12	TRAGEDY	COMEDY	12
12	BLOW	DRY	13	HANDBAG	PURSE	13
13	SCHOOL	DAY	14	AXE	CHOP	14
14	SKIN	DEEP	15	HAM	EGG	14
15	TAIL	END	15	CASTLE	SAND	15
16	COMMON	LAND	15	INJUSTICE	LAW	15
17	PRIME	NUMBER	15	TEETH	MOUTH	15
18	SEA	SHORE	15	LAUNDRY	CLOTHES	16
19	BUILDING	SITE	16	ABRUPT	SHORT	16
20	EYE	BALL	16	IRON	STEEL	16
21	LADY	BIRD	16	DROP	FALL	16
22	POWER	STATION	16	MILK	COW	16
23	TROUBLE	MAKER	16	AMBULANCE	HOSPITAL	17
24	THEME	PARK	17	ANGER	RAGE	17
25	COPY	CAT	17	BARGAIN	SALE	17
26	POP	MUSIC	18	DESK	WORK	17
27	LOG	CABIN	18	FIELD	GRASS	17
28	BEAR	HUG	19	SCARF	NECK	18
29	BICYCLE	PUMP	19	COUPLE	PAIR	19
30	COAT	HANGER	19	DOLPHIN	WHALE	19
31	SECRET	GARDEN	19	DISOBEY	NAUGHTY	19
32	PILLOW	TALK	20	PRISONER	JAIL	19
33	SOUL	MATE	20	FOOT	SHOE	19
34	WORLD	WIDE	20	MARGIN	PAPER	19
35	DOOR	HANDLE	20	FAILURE	SUCCESS	20
36	KITCHEN	SINK	20	CELLAR	BASEMENT	21
37	NUT	CRACKER	20	REALM	KINGDOM	21
38	DRAGON	FLY	21	SEASON	SPRING	21
39	SCREW	DRIVER	22	CALORIE	DIET	22
40	WASHING	MACHINE	22	BOAT	SHIP	23
41	BEER	GLASS	23	INNOCENT	GUILTY	24
42	HEAD	ACHE	23	ATHLETE	RUNNER	25
43	SOFA	BED	24	PUPIL	TEACHER	26
44	BEE	STING	24	RUMOUR	GOSSIP	26
45	BLUE	SKY	24	BUN	OVEN	27
46	HEART	BEAT	24	DIRTY	CLEAN	27
47	HEAVY	WEIGHT	24	FANTASY	DREAM	27
48	ICE	COLD	24	HONESTY	TRUTH	27
49	COVER	UP	25	POSTCARD	HOLIDAY	27
50	DART	BOARD	25	ASHTRAY	CIGARETTES	28
51	GRAPE	FRUIT	26	BARRACK	ARMY	28
52	SENIOR	CITIZEN	26	DIG	HOLE	29

53	COUCH	POTATO	27	DISH	PLATE	29
54	CLING	FILM	28	DOVE	PEACE	29
55	COTTON	WOOL	30	PARCEL	POST	29
56	WEDDING	BELL	30	TENANT	LANDLORD	30
57	COMIC	STRIP	31	CELLO	VIOLIN	31
58	HUMBLE	PIE	32	BASIC	SIMPLE	31
59	DOLL	HOUSE	33	FABRIC	CLOTH	33
60	MARKET	PLACE	34	PLUG	SOCKET	35
	Tot.		19.4	Tot		19.9

Appendix 5.3 List A,B,C and D of Experiment 5a, 5b and 6

LIST A

	Low associates			**Two-word phrases**		
	CUE	TARGET	ASSOC.	ASSOC. TYPE		ASSOC.
1	BARON	KNIGHT	9	MAGIC	BOX	9
2	STRICT	SEVERE	10	GAS	FIRE	10
3	AUTHORITY	GOVERNMENT	12	EAR	RING	12
4	AXE	CHOP	14	SCHOOL	DAY	14
5	TEETH	MOUTH	15	PRIME	NUMBER	15
6	DROP	FALL	16	LADY	BIRD	16
7	BARGAIN	SALE	17	COPY	CAT	17
8	PRISONER	JAIL	19	KITCHEN	SINK	20
9	CELLAR	BASEMENT	21	PILLOW	TALK	20
10	BOAT	SHIP	23	WASHING	MACHINE	22
11	RUMOUR	GOSSIP	26	ICE	COLD	24
12	HONESTY	TRUTH	27	BEE	STING	24
13	DIG	HOLE	29	SENIOR	CITIZEN	26
14	TENANT	LANDLORD	30	WEDDING	BELL	30
15	PLUG	SOCKET	35	MARKET	PLACE	34
	TOT.		***20.2***	***TOT.***		***19.5***

LIST B

	Low associates			**Two-word phrases**		
	CUE	TARGET	ASSOC.	ASSOC. TYPE		ASSOC.
1	GREEK	LATIN	9	MEMORY	LOSS	9
2	TABLECLOTH	CHECK	10	POT	PLANT	10
3	DEFENCE	ATTACK	12	LEATHER	BELT	12
4	HAM	EGG	14	SKIN	DEEP	15
5	MILK	COW	16	SEA	SHORE	15
6	LAUNDRY	CLOTHES	16	POWER	STATION	16
7	DESK	WORK	17	POP	MUSIC	18
8	DISOBEY	NAUGHTY	19	SECRET	GARDEN	19
9	FAILURE	SUCCESS	20	DOOR	HANDLE	20
10	CALORIE	DIET	22	SCREW	DRIVER	22
11	PUPIL	TEACHER	26	HEAVY	WEIGHT	24
12	FANTASY	DREAM	27	SOFA	BED	24
13	BARRACK	ARMY	28	GRAPE	FRUIT	26
14	PARCEL	POST	29	COTTON	WOOL	30
15	FABRIC	CLOTH	33	DOLL	HOUSE	33
	TOT.		***19.2***	***TOT.***		***19.5***

LIST C

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	ASSOC. TYPE		ASSOC.
1	SHARE	GIVE	9	SHOP	FRONT	9
2	STEADY	FIRM	11	BABY	FACE	11
3	TRAGEDY	COMEDY	12	RUN	AWAY	12
4	CASTLE	SAND	15	TAIL	END	15
5	ABRUPT	SHORT	16	BUILDING	SITE	16
6	AMBULANCE	HOSPITAL	17	TROUBLE	MAKER	16
7	FIELD	GRASS	17	LOG	CABIN	18
8	DOLPHIN	WHALE	19	COAT	HANGER	19
9	MARGIN	PAPER	19	WORLD	WIDE	20
10	SEASON	SPRING	21	DRAGON	FLY	21
11	ATHLETE	RUNNER	25	HEAD	ACHE	23
12	DIRTY	CLEAN	27	HEART	BEAT	24
13	ASHTRAY	CIGARETTES	28	DART	BOARD	25
14	DOVE	PEACE	29	CLING	FILM	28
15	BASIC	SIMPLE	31	HUMBLE	PIE	32
	TOT.		***19.7***	***TOT.***		***19.3***

LIST D

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	ASSOC. TYPE		ASSOC.
1	EXCITEMENT	FUN	10	BUSINESS	MAN	10
2	GATE	FENCE	11	TOOTH	BRUSH	11
3	HANDBAG	PURSE	13	BLOW	DRY	13
4	INJUSTICE	LAW	15	COMMON	LAND	15
5	IRON	STEEL	16	EYE	BALL	16
6	ANGER	RAGE	17	THEME	PARK	17
7	SCARF	NECK	18	BEAR	HUG	19
8	COUPLE	PAIR	19	BICYCLE	PUMP	19
9	FOOT	SHOE	19	SOUL	MATE	20
10	REALM	KINGDOM	21	NUT	CRACKER	20
11	INNOCENT	GUILTY	24	BEER	GLASS	23
12	POSTCARD	HOLIDAY	27	BLUE	SKY	24
13	BUN	OVEN	27	COVER	UP	25
14	DISH	PLATE	29	COUCH	POTATO	27
15	CELLO	VIOLIN	31	COMIC	STRIP	31
	TOT		***19.8***	***TOT***		***19.3***

Appendix 5.4 Participants' Data from Experiment 5a

Incidental test (N=24)

Ss	*time*	*L1PH*	*L1L*	*L2PH*	*L2L*	*DPH*	*DL*
s01	42.28	.33	.20	.33	.13	.20	.10
s02	68.80	.53	.40	.40	.40	.17	.13
s03	54.92	.53	.27	.20	.27	.10	.13
s04	55.23	.40	.20	.47	.33	.17	.07
s05	98.48	.40	.53	.67	.73	.13	.23
s06	55.20	.27	.27	.40	.47	.23	.10
s07	91.18	.47	.53	.60	.40	.17	.23
s08	73.65	.33	.40	.40	.47	.13	.23
s09	86.82	.53	.47	.73	.53	.17	.23
s10	52.52	.60	.20	.33	.33	.23	.07
s11	69.03	.47	.20	.60	.53	.20	.20
s12	102.45	.33	.53	.47	.73	.27	.37
s13	77.33	.40	.27	.20	.33	.17	.27
s14	100.18	.27	.13	.27	.27	.27	.30
s15	54.67	.33	.33	.40	.47	.07	.23
s16	71.68	.33	.13	.27	.33	.23	.17
S33S	48.47	.27	.47	.47	.33	.13	.10
S34S	73.08	.53	.33	.40	.53	.27	.07
S35	54.27	.47	.13	.33	.27	.13	.23
S36	93.45	.40	.33	.80	.87	.17	.13
S37	81.17	.40	.20	.53	.80	.23	.27
S38	125.70	.40	.27	.53	.80	.30	.27
S39	58.02	.20	.20	.27	.33	.03	.27
S40	79.83	.33	.33	.27	.27	.20	.20

Intentional test (N=24)

Ss	*Time*	*L1PH*	*L1L*	*L2PH*	*L2L*	*DPH*	*DL*
s17	57.72	.40	.13	1.00	.53	.00	.00
s18	43.13	.13	.00	.53	.53	.00	.00
s19	63.92	.20	.00	.73	.47	.00	.00
s20	21.65	.13	.07	.20	.13	.00	.00
s21	62.70	.07	.20	.67	1.00	.00	.00
s22	86.82	.07	.13	.40	.87	.00	.00
s23	73.52	.33	.00	.67	.53	.00	.00
s24	21.37	.00	.00	.33	.27	.00	.00
s25	21.82	.07	.07	.20	.20	.00	.00
s26	66.18	.00	.07	.73	.80	.00	.00
s27	79.87	.20	.40	.87	.73	.00	.00
s28	80.27	.00	.07	.27	.40	.00	.00
s29	57.27	.20	.07	.53	.60	.00	.00
s30	51.87	.27	.20	.33	.80	.00	.00
s31	108.15	.07	.27	.60	.60	.00	.00
s32	94.28	.13	.13	.47	.87	.00	.00
S41	44.95	.07	.13	.53	.67	.00	.00
S42s	76.70	.40	.33	.93	.93	.00	.00
S43	103.00	.00	.00	.73	.93	.00	.00
S44	89.02	.33	.00	.60	.60	.00	.00
S45	55.58	.13	.20	.73	.60	.00	.00
S46	54.63	.27	.13	.60	.80	.00	.00
S47	47.43	.20	.07	.47	.67	.03	.00
S48	65.90	.07	.13	.73	.73	.00	.00

Appendix 5.5 Item Analysis Data from Experiment 5a

Low associates			*Incidental test*			*Intentional test*		
cue	*target*	*Ass.*	*Lop1*	*Lop2*	*baseline*	*Lop1*	*Lop2*	*D*
BARON	KNIGHT	9	.33	.83	.33	.00	.67	.00
GREEK	LATIN	9	.17	.50	.25	.33	.83	.00
SHARE	GIVE	9	.00	.67	.08	.17	.67	.00
EXCITEMENT	FUN	10	.17	.50	.08	.17	.83	.00
STRICT	SEVERE	10	.17	.50	.00	.17	.17	.00
TABLECLOTH	CHECK	10	.17	.00	.25	.17	.50	.00
GATE	FENCE	11	.17	.17	.08	.00	.83	.00
STEADY	FIRM	11	.00	.17	.00	.00	.33	.00
AUTHORITY	GOVERNMENT	12	.00	.17	.17	.17	.83	.00
DEFENCE	ATTACK	12	.50	.50	.08	.17	.33	.00
TRAGEDY	COMEDY	12	.50	.67	.00	.33	.50	.00
HANDBAG	PURSE	13	.50	.33	.33	.00	.83	.00
AXE	CHOP	14	.17	.33	.08	.00	.67	.00
HAM	EGG	14	.67	.00	.00	.17	.67	.00
CASTLE	SAND	15	.33	.67	.00	.17	.67	.00
INJUSTICE	LAW	15	.50	.33	.08	.00	.67	.00
TEETH	MOUTH	15	.33	.33	.08	.17	.83	.00
ABRUPT	SHORT	16	.33	.50	.25	.17	.33	.00
DROP	FALL	16	.50	.17	.25	.00	.67	.00
IRON	STEEL	16	.17	.17	.00	.17	.33	.00
LAUNDRY	CLOTHES	16	.00	.17	.08	.00	.17	.00
MILK	COW	16	.17	.33	.08	.00	.83	.00
AMBULANCE	HOSPITAL	17	.33	.50	.08	.17	.83	.00
ANGER	RAGE	17	.50	.33	.08	.00	.50	.00
BARGAIN	SALE	17	.33	.33	.25	.17	.50	.00
DESK	WORK	17	.00	.00	.08	.00	.00	.00
FIELD	GRASS	17	.17	.50	.25	.00	.83	.00
SCARF	NECK	18	.33	.50	.17	.00	.50	.00
COUPLE	PAIR	19	.17	.50	.17	.17	1.00	.00
DISOBEY	NAUGHTY	19	.17	.33	.33	.00	.17	.00
DOLPHIN	WHALE	19	.17	.83	.08	.33	1.00	.00
FOOT	SHOE	19	.17	.17	.08	.00	.33	.00
MARGIN	PAPER	19	.17	.67	.50	.00	.50	.00
PRISONER	JAIL	19	.00	.33	.25	.00	.83	.00
FAILURE	SUCCESS	20	.33	.50	.17	.17	.67	.00
CELLAR	BASEMENT	21	.33	.50	.25	.00	.83	.00
REALM	KINGDOM	21	.17	.17	.17	.00	.50	.00
SEASON	SPRING	21	.33	.67	.25	.00	.83	.00
CALORIE	DIET	22	.17	.83	.17	.33	.67	.00
BOAT	SHIP	23	.50	.50	.08	.00	.83	.00
INNOCENT	GUILTY	24	.67	.50	.50	.33	.67	.00
ATHLETE	RUNNER	25	.17	.67	.42	.33	.83	.00
PUPIL	TEACHER	26	.33	.67	.08	.17	.67	.00
RUMOUR	GOSSIP	26	.33	.50	.25	.33	.83	.00
BUN	OVEN	27	.17	.50	.33	.33	.83	.00
DIRTY	CLEAN	27	.33	.50	.25	.00	.33	.00
FANTASY	DREAM	27	.50	.67	.25	.50	.83	.00
HONESTY	TRUTH	27	.67	.67	.25	.00	1.00	.00
POSTCARD	HOLIDAY	27	.17	.83	.25	.17	.83	.00
ASHTRAY	CIGARETTES	28	1.00	.83	.83	.00	.67	.00
BARRACK	ARMY	28	.33	.67	.33	.00	.83	.00
DIG	HOLE	29	.67	.67	.25	.33	.50	.00

DISH	PLATE	29	.00	.33	.17	.00	.67	.00
DOVE	PEACE	29	.33	.50	.25	.00	.67	.00
PARCEL	POST	29	.17	.17	.25	.00	.67	.00
TENANT	LANDLORD	30	.67	.83	.00	.33	1.00	.00
BASIC	SIMPLE	31	.33	.33	.00	.00	.00	.00
CELLO	VIOLIN	31	.50	.50	.50	.17	1.00	.00
FABRIC	CLOTH	33	.33	.17	.17	.17	.17	.00
PLUG	SOCKET	35	.50	.67	.17	.00	.67	.00

Two-word Phrases			*Incidental test*			*Intentional test*		
Cue	*target*	*Ass.*	*Lop1*	*Lop2*	*baseline*	*Lop1*	*Lop2*	*baseline*
MAGIC	BOX	9	.17	.33	.00	.00	.83	.00
MEMORY	LOSS	9	.33	.83	.17	.00	.17	.00
SHOP	FRONT	9	.17	.00	.00	.00	.00	.00
BUSINESS	MAN	10	.33	.50	.17	.17	.50	.00
GAS	FIRE	10	.33	.17	.08	.00	.33	.00
POT	PLANT	10	.67	.33	.00	.33	.33	.00
BABY	FACE	11	.17	.00	.08	.17	.67	.00
TOOTH	BRUSH	11	.17	.17	.17	.00	.67	.00
EAR	RING	12	.17	.50	.08	.33	.50	.00
LEATHER	BELT	12	.17	.33	.17	.00	.50	.00
RUN	AWAY	12	.00	.33	.17	.00	.00	.00
BLOW	DRY	13	.00	.00	.00	.17	.50	.00
SCHOOL	DAY	14	.00	.00	.08	.17	.67	.00
COMMON	LAND	15	.00	.00	.00	.00	.17	.00
PRIME	NUMBER	15	.17	.33	.00	.00	.50	.00
SEA	SHORE	15	.33	.33	.00	.33	.67	.00
SKIN	DEEP	15	.33	.33	.25	.00	.33	.00
TAIL	END	15	.33	.17	.17	.00	.33	.00
BUILDING	SITE	16	.50	.67	.17	.00	.33	.00
EYE	BALL	16	.50	.83	.00	.33	.50	.08
LADY	BIRD	16	.33	.17	.25	.00	.83	.00
POWER	STATION	16	.17	.00	.08	.00	.33	.00
TROUBLE	MAKER	16	.33	.50	.25	.00	.33	.00
COPY	CAT	17	.67	.67	.08	.50	.83	.00
THEME	PARK	17	.33	.83	.17	.17	1.00	.00
LOG	CABIN	18	.00	.33	.00	.00	.33	.00
POP	MUSIC	18	.67	.50	.42	.00	.67	.00
BEAR	HUG	19	.83	.67	.08	.17	.50	.00
BICYCLE	PUMP	19	.00	.50	.17	.17	.33	.00
COAT	HANGER	19	.33	.83	.17	.17	.67	.00
SECRET	GARDEN	19	.17	.17	.08	.00	.33	.00
DOOR	HANDLE	20	.17	.33	.25	.00	.33	.00
KITCHEN	SINK	20	.33	.50	.08	.00	.67	.00
NUT	CRACKER	20	.67	.33	.25	.17	.83	.00
PILLOW	TALK	20	.50	.67	.17	.17	.83	.00
SOUL	MATE	20	.50	.50	.00	.17	1.00	.00
WORLD	WIDE	20	.67	.50	.00	.00	.33	.00
DRAGON	FLY	21	.83	.67	.08	.17	.67	.00
SCREW	DRIVER	22	.83	.83	.42	.50	1.00	.00
WASHING	MACHINE	22	.17	.33	.08	.50	.50	.00
BEER	GLASS	23	.00	.00	.08	.00	.83	.00
HEAD	ACHE	23	.67	.50	.08	.50	.17	.00
BEE	STING	24	.67	.83	.25	.50	.83	.00
BLUE	SKY	24	.83	.00	.08	.00	.83	.00
HEART	BEAT	24	.67	.67	.17	.17	.33	.00
HEAVY	WEIGHT	24	.17	.17	.50	.00	.83	.00

ICE	COLD	24	.50	.33	.25	.17	1.00	.00
SOFA	BED	24	.83	.83	.58	.33	.67	.00
COVER	UP	25	.33	.33	.08	.33	.50	.00
DART	BOARD	25	.67	1.00	.42	.00	.67	.00
GRAPE	FRUIT	26	.17	.33	.33	.33	1.00	.00
SENIOR	CITIZEN	26	.50	.33	.08	.33	.83	.00
COUCH	POTATO	27	.50	.67	.58	.50	.67	.00
CLING	FILM	28	.67	.67	.33	.17	.67	.00
COTTON	WOOL	30	.83	1.00	.67	.17	.83	.00
WEDDING	BELL	30	.50	.83	.25	.17	.83	.00
COMIC	STRIP	31	.17	.00	.17	.33	.50	.00
HUMBLE	PIE	32	.67	.50	.25	.50	.50	.00
DOLL	HOUSE	33	.83	.67	.50	.00	.67	.00
MARKET	PLACE	34	.33	.50	.42	.00	.67	.00

Appendix 5.6 Experiment 5b and 6 InclusionTest Instructions

In this task you will see a series of words presented to you one at a time. Most of these words will be the same words as those you saw in the first task. In the first task you saw a pair of words, one appearing on the left and one on the right. In this task you will see only the words that appeared on the left in the first task. Your task is to use these words as a cue to remember the associated word that you saw appearing on the right handside of the screen in the first task. You should not expect to be able to remember the associated word of all the words you will see presented in this task, as some of these words do not correspond to the previous words.

If you can remember the associated word then I would like you to say aloud that associated word. If you find that you cannot remember seeing the word before or you cannot recall the associated second word, then I would like you to say the first word that comes to mind. But in the first place you should try as hard as you can to remember the word you saw in the first task.

Appendix 5.7 Participants' Data from Experiment 5b.
Inclusion test
(N=16)

Ss	*Time*	*L1PH*	*L1L*	*L2PH*	*L2L*	*DPH*	*DL*
s49	170.00	.47	.00	.80	.80	.40	.20
s50	139.27	.53	.47	.40	.87	.07	.30
s51	121.63	.60	.20	.73	.80	.17	.20
s52	119.95	.47	.27	.87	.47	.33	.20
s53	112.33	.47	.27	.67	.67	.20	.03
s54	121.38	.47	.27	.80	.67	.27	.20
s55	295.82	.60	.60	.73	.73	.20	.20
s56	200.78	.60	.67	.93	.93	.23	.23
s57	114.12	.40	.40	.93	.60	.17	.20
s58	163.43	.67	.73	.73	.80	.10	.40
s59	169.15	.60	.60	.47	.80	.23	.23
s60	121.30	.47	.53	.93	1.00	.17	.27
s61	183.25	.47	.40	.67	.87	.13	.20
s62	101.02	.27	.47	.47	.53	.13	.17
s63	124.42	.33	.27	.87	.80	.13	.07
s64	166.27	.47	.47	.53	.93	.23	.13
Tot.	151.50	.49	.41	.72	.76	.20	.20

Appendix 5.8 Item Analysis Data from Experiment 5b.

Low associates			*Inclusion Test*		
word	*target*	*Ass.*	*L1*	*L2*	*D*
BARON	KNIGHT	9	.25	.50	.50
GREEK	LATIN	9	.25	1.00	.12
SHARE	GIVE	9	.25	.50	.00
EXCITEMENT	FUN	10	.50	1.00	.00
STRICT	SEVERE	10	.00	.50	.12
TABLECLOTH	CHECK	10	.25	.25	.00
GATE	FENCE	11	.00	1.00	.12
STEADY	FIRM	11	.00	.25	.25
AUTHORITY	GOVERNMENT	12	.25	1.00	.00
DEFENCE	ATTACK	12	.25	.75	.12
TRAGEDY	COMEDY	12	.75	.50	.25
HANDBAG	PURSE	13	.50	1.00	.00
AXE	CHOP	14	.25	.75	.25
HAM	EGG	14	.50	1.00	.00
CASTLE	SAND	15	.25	.50	.12
INJUSTICE	LAW	15	.00	1.00	.00
TEETH	MOUTH	15	.50	.75	.25
ABRUPT	SHORT	16	.50	.50	.12
DROP	FALL	16	.50	.00	.25
IRON	STEEL	16	.75	.75	.25
LAUNDRY	CLOTHES	16	.00	.25	.12
MILK	COW	16	.25	.75	.12
AMBULANCE	HOSPITAL	17	.75	1.00	.12
ANGER	RAGE	17	.50	1.00	.00
BARGAIN	SALE	17	.00	1.00	.38
DESK	WORK	17	.00	.50	.00
FIELD	GRASS	17	.25	.75	.12
SCARF	NECK	18	.00	.50	.00
COUPLE	PAIR	19	.75	.75	.00
DISOBEY	NAUGHTY	19	.00	.75	.12
DOLPHIN	WHALE	19	1.00	1.00	.12
FOOT	SHOE	19	.00	1.00	.00
MARGIN	PAPER	19	.50	.50	.12
PRISONER	JAIL	19	.00	1.00	.38
FAILURE	SUCCESS	20	.25	1.00	.38
CELLAR	BASEMENT	21	.25	1.00	.12
REALM	KINGDOM	21	.50	.75	.25
SEASON	SPRING	21	1.00	1.00	.12
CALORIE	DIET	22	.75	1.00	.00
BOAT	SHIP	23	.25	1.00	.25
INNOCENT	GUILTY	24	.50	1.00	.50
ATHLETE	RUNNER	25	.75	1.00	.50
PUPIL	TEACHER	26	.75	1.00	.12
RUMOUR	GOSSIP	26	.50	1.00	.62
BUN	OVEN	27	.50	.75	.00
DIRTY	CLEAN	27	1.00	.50	.38
FANTASY	DREAM	27	.50	1.00	.38
HONESTY	TRUTH	27	.50	1.00	.38
POSTCARD	HOLIDAY	27	.25	.75	.25
ASHTRAY	CIGARETTES	28	1.00	1.00	.75
BARRACK	ARMY	28	.25	1.00	.25
DIG	HOLE	29	.75	.50	.50
DISH	PLATE	29	.25	1.00	.12

DOVE	PEACE	29	.25	.75	.25
PARCEL	POST	29	1.00	.50	.12
TENANT	LANDLORD	30	.50	1.00	.25
BASIC	SIMPLE	31	.50	.25	.00
CELLO	VIOLIN	31	.75	1.00	.25
FABRIC	CLOTH	33	.50	.25	.38
PLUG	SOCKET	35	.25	.75	.62
Two-word Phrases					
MAGIC	BOX	9	.25	.50	.00
MEMORY	LOSS	9	.25	.75	.25
SHOP	FRONT	9	.00	.00	.00
BUSINESS	MAN	10	.25	.75	.12
GAS	FIRE	10	.00	.75	.00
POT	PLANT	10	.50	.75	.12
BABY	FACE	11	.25	.75	.12
TOOTH	BRUSH	11	.25	.75	.12
EAR	RING	12	.50	.25	.00
LEATHER	BELT	12	.50	1.00	.12
RUN	AWAY	12	.00	.50	.12
BLOW	DRY	13	.00	.50	.00
SCHOOL	DAY	14	.00	.25	.00
COMMON	LAND	15	.00	.00	.00
PRIME	NUMBER	15	.00	.25	.00
SEA	SHORE	15	.50	1.00	.00
SKIN	DEEP	15	.75	1.00	.25
TAIL	END	15	.25	.75	.12
BUILDING	SITE	16	.50	1.00	.25
EYE	BALL	16	.75	.75	.38
LADY	BIRD	16	.25	.75	.25
POWER	STATION	16	.25	.50	.00
TROUBLE	MAKER	16	.50	.75	.25
COPY	CAT	17	1.00	1.00	.38
THEME	PARK	17	.75	1.00	.38
LOG	CABIN	18	.75	.50	.00
POP	MUSIC	18	.75	1.00	.12
BEAR	HUG	19	.75	.75	.12
BICYCLE	PUMP	19	.50	.50	.12
COAT	HANGER	19	.75	1.00	.38
SECRET	GARDEN	19	.75	.75	.38
DOOR	HANDLE	20	.50	.25	.00
KITCHEN	SINK	20	.25	.00	.38
NUT	CRACKER	20	.75	.75	.38
PILLOW	TALK	20	.75	1.00	.38
SOUL	MATE	20	.50	.75	.25
WORLD	WIDE	20	.75	1.00	.25
DRAGON	FLY	21	.75	1.00	.38
SCREW	DRIVER	22	.50	1.00	.50
WASHING	MACHINE	22	.75	.50	.38
BEER	GLASS	23	.00	1.00	.00
HEAD	ACHE	23	.50	.75	.00
BEE	STING	24	.25	1.00	.12
BLUE	SKY	24	.25	.50	.50
HEART	BEAT	24	.50	.50	.12
HEAVY	WEIGHT	24	.50	1.00	.25
ICE	COLD	24	.75	.75	.12
SOFA	BED	24	.25	.75	.12
COVER	UP	25	.50	.50	.25
DART	BOARD	25	1.00	1.00	.50

GRAPE	FRUIT	26	.50	1.00	.00
SENIOR	CITIZEN	26	1.00	.50	.12
COUCH	POTATO	27	.75	.75	.00
CLING	FILM	28	1.00	1.00	.50
COTTON	WOOL	30	.75	.75	.50
WEDDING	BELL	30	.00	1.00	.38
COMIC	STRIP	31	.25	.50	.00
HUMBLE	PIE	32	1.00	1.00	.50
DOLL	HOUSE	33	.75	1.00	.25
MARKET	PLACE	34	1.00	1.00	.38

Appendix to Chapter 6

Appendix 6.1 Design of Experiment 6

Tot no. Of word-pairs = 120
Word pairs which constitute a phrase = 60
Word pairs of Low association strength = 60
Five lists of words: A,B,C,D,E
Each list of 24 word-pairs has 12 word-pairs which constitute a phrase, and 12 with matched low association strength
Study list: Target word-pairs = 96 Distractor word-pairs = 24 + 24 fillers words

Design: (The same design is repeated for incidental and intentional retrieval conditions)

		PHONEMIC		SEMANTIC		
		visual	**auditory**	**visual**	**visual**	**distractors**
I	**1**	**A**	**B**	**C**	**D**	**E**
	2	**E**	**A**	**B**	**C**	**D**
	3	**D**	**E**	**A**	**B**	**C**
	4	**C**	**D**	**E**	**A**	**B**
	5	**B**	**C**	**D**	**E**	**A**

		SEMANTIC		PHONEMIC		
		visual	**auditory**	**visual**	**visual**	**distractors**
II	**1**	**A**	**B**	**C**	**D**	**E**
	2	**E**	**A**	**B**	**C**	**D**
	3	**D**	**E**	**A**	**B**	**C**
	4	**C**	**D**	**E**	**A**	**B**
	5	**B**	**C**	**D**	**E**	**A**

		PHONEMIC		SEMANTIC		
		auditory	**visual**	**auditory**	**visual**	
III	**1**	**A**	**B**	**C**	**D**	**E**
	2	**E**	**A**	**B**	**C**	**D**
	3	**D**	**E**	**A**	**B**	**C**
	4	**C**	**D**	**E**	**A**	**B**
	5	**B**	**C**	**D**	**E**	**A**

		SEMANTIC		PHONEMIC		
		auditory	**visual**	**auditory**	**visual**	
IV	**1**	**A**	**B**	**C**	**D**	**E**
	2	**E**	**A**	**B**	**C**	**D**
	3	**D**	**E**	**A**	**B**	**C**
	4	**C**	**D**	**E**	**A**	**B**
	5	**B**	**C**	**D**	**E**	**A**

Appendix 6.2 Lists A,B,C,D,E and the filler list of Experiment 6

LIST A

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	CUE	TARGET	ASSOC.
1	BARON	KNIGHT	9	MAGIC	BOX	9
2	TABLECLOTH	CHECK	10	POT	PLANT	10
3	TRAGEDY	COMEDY	12	RUN	AWAY	12
4	INJUSTICE	LAW	15	COMMON	LAND	15
5	DROP	FALL	16	LADY	BIRD	16
6	DESK	WORK	17	POP	MUSIC	18
7	FAILURE	SUCCESS	20	DOOR	HANDLE	20
8	BOAT	SHIP	23	WASHING	MACHINE	22
9	BUN	OVEN	27	BLUE	SKY	24
10	ASHTRAY	CIGARETTES	28	DART	BOARD	25
11	PARCEL	POST	29	COTTON	WOOL	30
12	PLUG	SOCKET	35	MARKET	PLACE	34
	TOT.		***20.0***	***TOT.***		***19.6***

LIST B

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	CUE	TARGET	ASSOC.
1	GREEK	LATIN	9	MEMORY	LOSS	9
2	STEADY	FIRM	11	BABY	FACE	11
3	HANDBAG	PURSE	13	BLOW	DRY	13
4	TEETH	MOUTH	15	PRIME	NUMBER	15
5	MILK	COW	16	POWER	STATION	16
6	FIELD	GRASS	17	LOG	CABIN	18
7	MARGIN	PAPER	19	WORLD	WIDE	20
8	CALORIE	DIET	22	SCREW	DRIVER	22
9	RUMOUR	GOSSIP	26	BEE	STING	24
10	POSTCARD	HOLIDAY	27	COVER	UP	25
11	DOVE	PEACE	29	CLING	FILM	28
12	FABRIC	CLOTH	33	DOLL	HOUSE	33
	TOT.		***19.5***	***TOT.***		***19.7***

LIST C

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	CUE	TARGET	ASSOC.
1	SHARE	GIVE	9	SHOP	FRONT	9
2	GATE	FENCE	11	TOOTH	BRUSH	11
3	AXE	CHOP	14	SCHOOL	DAY	14
4	LAUNDRY	CLOTHES	16	SEA	SHORE	15
5	AMBULANCE	HOSPITAL	17	TROUBLE	MAKER	16
6	SCARF	NECK	18	BEAR	HUG	19
7	FOOT	SHOE	19	SOUL	MATE	20
8	SEASON	SPRING	21	DRAGON	FLY	21
9	PUPIL	TEACHER	26	SOFA	BED	24
10	HONESTY	TRUTH	27	ICE	COLD	24
11	DISH	PLATE	29	COUCH	POTATO	27
12	BASIC	SIMPLE	31	HUMBLE	PIE	32
	TOT.		***19.8***	***TOT.***		***19.3***

LIST D

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	CUE	TARGET	ASSOC.
1	EXCITEMENT	FUN	10	BUSINESS	MAN	10
2	AUTHORITY	GOVERNMENT	12	EAR	RING	12
3	HAM	EGG	14	SKIN	DEEP	15
4	ABRUPT	SHORT	16	BUILDING	SITE	16
5	ANGER	RAGE	17	THEME	PARK	17
6	COUPLE	PAIR	19	BICYCLE	PUMP	19
7	PRISONER	JAIL	19	NUT	CRACKER	20
8	REALM	KINGDOM	21	PILLOW	TALK	20
9	ATHLETE	RUNNER	25	HEAD	ACHE	23
10	FANTASY	DREAM	27	HEAVY	WEIGHT	24
11	DIG	HOLE	29	SENIOR	CITIZEN	26
12	CELLO	VIOLIN	31	COMIC	STRIP	31
	TOT.		***20***	***TOT***		***19.4***

LIST E

	Low associates			Two-word phrases		
	CUE	TARGET	ASSOC.	CUE	TARGET	ASSOC.
1	STRICT	SEVERE	10	GAS	FIRE	10
2	DEFENCE	ATTACK	12	LEATHER	BELT	12
3	CASTLE	SAND	15	TAIL	END	15
4	IRON	STEEL	16	EYE	BALL	16
5	BARGAIN	SALE	17	COPY	CAT	17
6	DOLPHIN	WHALE	19	COAT	HANGER	19
7	DISOBEY	NAUGHTY	19	SECRET	GARDEN	19
8	CELLAR	BASEMENT	21	KITCHEN	SINK	20
9	INNOCENT	GUILTY	24	BEER	GLASS	23
10	DIRTY	CLEAN	27	HEART	BEAT	24
11	BARRACK	ARMY	28	GRAPE	FRUIT	26
12	TENANT	LANDLORD	30	WEDDING	BELL	30
	TOT		***19.8***	***TOT***		***19.2***

List F, not counted fillers

GOLD	SILVER
TRUCK	LORRY
HEAVEN	HELL
MONTH	YEAR
ARM	LEG
CROWD	PEOPLE
DISAPPEAR	VANISH
BLOSSOM	FLOWER
GRUMBLE	MOAN
CONCEPT	IDEA
GIFT	PRESENT
TRUE	FALSE
DIFFICULT	HARD
BARK	DOG
TRIGGER	GUN
SOBER	DRUNK
TIMID	SHY
NOVEL	BOOK
THUNDER	LIGHTNING
AUNT	UNCLE
WHITE	BLACK
FRAGRANCE	SMELL
COB	CORN
STROLL	WALK

Appendix 6.3 Experiment 6 Post-Test Instructions

I am now going to show you all the word-pairs that you produced.

For each word-pair I would like you to tell whether it corresponds to the pairs presented in the first task - the task where you had to make the "syllables" and the "pleasantness" judgements -.

Press the "yes" button if you recollect hearing or seeing that word pair in the first task.

Press the "no" button if you do not recollect hearing or seeing that word pair in the first task.

Appendix 6.4 Individual participants' data from the incidental and intentional test

Incidental condition

Ss	AL1PH	AL1L	AL2PH	AL2L	VL1PH	VL1L	VL2PH	VL2L	DPH	DL
S01	.33	.08	.50	.25	.42	.25	.58	.33	.17	.17
S02	.25	.33	.75	.17	.75	.33	.33	.25	.17	.17
S03	.33	.50	.58	.25	.42	.42	.33	.33	.33	.25
S04	.67	.50	.33	.42	.50	.25	.58	.17	.17	.00
S05	.50	.50	.50	.67	.42	.42	.50	.42	.25	.25
S06	.58	.17	.42	.58	.58	.58	.50	.42	.17	.25
S07	.25	.42	.42	.50	.58	.17	.50	.42	.00	.42
S08	.58	.25	.50	.33	.25	.42	.25	.50	.17	.08
s09	.25	.25	.67	.83	.50	.50	.50	.75	.17	.42
S10	.42	.17	.33	.50	.67	.33	.67	.50	.17	.33
S11	.42	.50	.33	.42	.42	.42	.75	.67	.33	.17
s12	.42	.17	.42	.17	.42	.17	.58	.33	.25	.33
s13s	.67	.25	.33	.58	.42	.33	.58	.25	.08	.25
s14	.17	.08	.33	.42	.25	.25	.25	.33	.25	.50
s15	.33	.67	.33	.42	.58	.17	.67	.58	.42	.08
S16	.17	.25	.50	.33	.50	.25	.58	.50	.17	.08
S17	.33	.25	.33	.25	.33	.42	.25	.50	.08	.25
s18	.33	.42	.00	.25	.50	.17	.17	.25	.00	.25
s19	.25	.08	.25	.08	.58	.25	.58	.17	.08	.17
s20	.33	.17	.50	.58	.25	.08	.50	.75	.33	.00

Intentional condition

Ss	AL1PH	AL1L	AL2PH	AL2L	VL1PH	VL1L	VL2PH	VL2L	DPH	DL
S21	.50	.33	.67	.83	.33	.17	.83	.83	.25	.25
S22	.83	1.00	.92	.92	.67	.75	1.00	1.00	.17	.25
s23	.08	.17	.58	.75	.50	.50	.67	.92	.17	.25
s24	.42	.58	.92	.75	.50	.58	.92	1.00	.33	.17
S25	.50	.25	.58	.75	.67	.42	.75	.92	.50	.08
S26	.33	.50	.92	1.00	.42	.67	.83	1.00	.00	.25
S27	.33	.50	.92	.75	.67	.58	.92	1.00	.17	.17
S28	.50	.58	.67	.75	.83	.58	.92	1.00	.08	.50
S29	.42	.42	.67	.67	.50	.50	.92	.58	.25	.08
S30	.58	.25	.58	.75	.50	.58	.83	1.00	.25	.25
s31	.58	.67	.58	.67	.42	.50	.75	.92	.17	.33
S32	.42	.58	.58	.92	.50	.58	.83	1.00	.33	.17
s33	.50	.33	.67	.75	.33	.58	.75	.75	.25	.17
s34	.33	.08	.58	.75	.33	.08	.58	.67	.25	.17
s35	.42	.50	.75	.67	.42	.42	.67	.58	.42	.17
S36	.25	.42	.42	.33	.08	.17	.33	.42	.17	.08
s37	.42	.25	.58	.67	.67	.33	.92	.92	.00	.00
s38	.33	.42	.58	.83	.58	.58	.67	1.00	.08	.17
s39	.33	.33	.92	.67	.08	.33	.67	.67	.17	.17
s40	.58	.42	.83	.67	.58	.58	.83	.83	.33	.33

Appendix 6.5 Item Analysis Data from Experiment 6

Low associates			Incidental test					conscious				
Cue	target	A ss	al1	al2	vl1	vl2	d	al1c	al2c	vl1c	vl2c	dc
baron	knight	9	.50	.50	.50	.75	.00	.25	.25	.25	.75	.00
greek	latin	9	.25	.50	.50	.75	.00	.25	.50	.25	.75	.00
share	give	9	.00	.50	.25	.50	.50	.00	.25	.00	.50	.00
excitement	fun	10	.50	.25	.00	1.0	.25	.00	.25	.00	.75	.00
strict	severe	10	.25	.75	.00	.00	.00	.00	.75	.00	.00	.00
tablecloth	check	10	.00	.00	.25	.00	.00	.00	.00	.00	.00	.00
gate	fence	11	.00	.50	.00	.25	.00	.00	.25	.00	.25	.00
steady	firm	11	.00	.25	.25	.00	.00	.00	.00	.25	.00	.00
authority	government	12	.00	.00	.00	.50	.00	.00	.00	.00	.50	.00
defence	attack	12	.25	.50	.25	.50	.00	.25	.50	.25	.50	.00
tragedy	comedy	12	.25	.50	.00	.50	.00	.25	.50	.00	.50	.00
handbag	purse	13	1.0	.75	.75	.25	.50	.75	.50	.00	.25	.25
axe	chop	14	.25	.50	.25	.25	.25	.25	.50	.00	.25	.00
ham	egg	14	.25	.25	.25	.00	.25	.25	.25	.00	.00	.00
castle	sand	15	.00	.25	.25	.25	.00	.00	.25	.00	.25	.00
injustice	law	15	.25	.00	.00	.25	.00	.00	.00	.00	.00	.00
teeth	mouth	15	.00	.00	.25	.25	.25	.00	.00	.00	.25	.25
abrupt	short	16	.25	.25	.25	.25	.25	.00	.00	.25	.25	.00
drop	fall	16	.25	.75	.25	.50	.50	.25	.75	.25	.50	.00
iron	steel	16	.00	.25	.00	.00	.00	.00	.25	.00	.00	.00
laundry	clothes	16	.50	.25	.00	.00	.25	.00	.25	.00	.00	.00
milk	cow	16	.25	.50	.00	.50	.00	.25	.25	.00	.50	.00
ambulance	hospital	17	.00	.75	.50	.25	.00	.00	.75	.25	.25	.00
anger	rage	17	.25	.00	.25	.50	.00	.00	.00	.25	.50	.00
bargain	sale	17	.75	.00	.50	.75	.00	.25	.00	.25	.50	.00
desk	work	17	.25	.25	.00	.00	.00	.00	.25	.00	.00	.00
field	grass	17	.00	.00	.50	.25	.25	.00	.00	.25	.25	.00
scarf	neck	18	.00	.25	.50	.25	.25	.00	.25	.00	.25	.00
couple	pair	19	.00	.25	.50	.50	.25	.00	.25	.00	.50	.00
disobey	naughty	19	.00	.50	.25	.50	.25	.00	.25	.25	.50	.00
dolphin	whale	19	.50	.75	.25	.50	.00	.00	.75	.00	.50	.00
foot	shoe	19	.25	.50	.25	.50	.25	.00	.50	.25	.00	.00
margin	paper	19	.75	.25	.25	.50	.25	.00	.25	.25	.50	.00
prisoner	jail	19	.50	.25	.50	.75	.00	.50	.25	.00	.75	.00
failure	success	20	.50	.50	.25	1.0	.25	.25	.50	.00	.75	.00
cellar	basement	21	.25	.25	.25	.00	.25	.25	.25	.00	.00	.00
realm	kingdom	21	.00	.50	.50	.00	.00	.00	.50	.50	.00	.00
season	spring	21	.25	.75	.50	.25	.00	.25	.75	.25	.25	.00
calorie	diet	22	.75	.50	.50	.75	.00	.50	.25	.00	.75	.00
boat	ship	23	.00	.75	.25	.25	.00	.00	.75	.25	.25	.00
innocent	guilty	24	.25	.50	.25	.75	.50	.00	.25	.00	.75	.00
athlete	runner	25	.25	.25	.00	1.0	.25	.00	.25	.00	.50	.00
pupil	teacher	26	.50	.75	.00	.50	.25	.25	.75	.00	.25	.00
rumour	gossip	26	.75	.00	1.0	.50	.75	.50	.00	.50	.50	.25
bun	oven	27	.25	.25	.25	.50	.00	.00	.25	.00	.50	.00
dirty	clean	27	.50	.50	.75	.75	.25	.00	.25	.25	.50	.00
fantasy	dream	27	.50	.50	.50	.75	1.0	.25	.50	.00	.75	.25
honesty	truth	27	.75	.50	.00	.50	.50	.00	.25	.00	.50	.00
postcard	holiday	27	.75	.50	.50	.25	.50	.25	.25	.25	.25	.25
ashtray	cigarettes	28	.50	1.0	.50	.50	.50	.00	1.0	.25	.50	.00
barrack	army	28	.25	1.0	.75	.75	.50	.00	.75	.25	.75	.00

dig	hole	29	.75	.25	.75	.25	.75	.00	.25	.25	.25	.00
dish	plate	29	.25	.50	.00	.50	.25	.00	.50	.00	.25	.00
dove	peace	29	.25	.50	.25	.75	.25	.25	.25	.25	.75	.00
parcel	post	29	.25	.75	.50	.25	.25	.25	.50	.25	.25	.00
tenant	landlord	30	.25	.25	.25	.50	.25	.25	.25	.25	.50	.00
basic	simple	31	.25	.25	.25	.25	.00	.25	.25	.00	.00	.00
cello	violin	31	.25	.50	.50	.75	.50	.25	.50	.50	.75	.00
fabric	cloth	33	.00	.00	.25	.25	.50	.00	.00	.00	.25	.00
plug	socket	35	.50	.25	.50	.25	.50	.25	.25	.25	.25	.00
Two-word phrases												
magic	box	9	.00	.00	.00	.25	.00	.00	.00	.00	.25	.00
memory	loss	9	.00	.00	.25	.50	.25	.00	.00	.00	.50	.00
shop	front	9	.00	.25	.00	.25	.00	.00	.00	.00	.00	.25
business	man	10	.50	.50	.50	.50	.00	.25	.25	.50	.50	.00
gas	fire	10	.25	.25	.50	.25	.25	.25	.25	.00	.25	.00
pot	plant	10	.50	.25	.75	.75	.25	.25	.25	.25	.75	.00
baby	face	11	.00	.25	.50	.75	.00	.00	.25	.00	.75	.00
tooth	brush	11	.50	.00	.25	.50	.25	.50	.00	.00	.50	.00
ear	ring	12	.50	.25	.50	.25	.25	.50	.25	.25	.25	.00
leather	belt	12	.00	.50	.50	.75	.00	.00	.50	.25	.75	.00
run	away	12	.25	.25	.25	.25	.00	.00	.25	.00	.25	.00
blow	dry	13	.00	.50	.00	.75	.00	.00	.25	.00	.50	.00
school	day	14	.00	.25	.50	.00	.25	.00	.00	.00	.00	.00
common	land	15	.25	.00	.25	.00	.00	.00	.00	.25	.00	.00
prime	number	15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
sea	shore	15	.00	.75	.25	.50	.00	.00	.75	.00	.50	.00
skin	deep	15	.00	.50	.50	.50	.00	.00	.50	.50	.50	.00
tail	end	15	.50	.25	1.0	.00	.00	.00	.25	.00	.00	.00
building	site	16	.50	.75	.00	.25	.25	.50	.50	.00	.25	.00
eye	ball	16	.50	.50	1.0	1.0	.25	.25	.25	.50	1.0	.00
lady	bird	16	.00	.25	.50	.25	.25	.00	.25	.25	.25	.00
power	station	16	.25	.00	.00	.00	.25	.25	.00	.00	.00	.00
trouble	maker	16	.50	.50	.50	.50	.00	.25	.25	.00	.25	.00
copy	cat	17	.75	.25	.75	.50	.50	.25	.25	.00	.25	.25
theme	park	17	.25	1.0	.75	1.0	.25	.25	.75	.00	1.0	.00
log	cabin	18	.50	.25	.25	.50	.00	.25	.00	.00	.50	.00
pop	music	18	.50	.75	.50	.00	.00	.50	.50	.25	.00	.00
bear	hug	19	.50	.75	1.0	.75	.00	.25	.75	.50	.75	.00
bicycle	pump	19	.25	.00	.00	.25	.00	.00	.00	.00	.25	.00
coat	hanger	19	.50	.25	.75	.25	.25	.25	.25	.25	.25	.00
secret	garden	19	.25	.25	.50	.50	.25	.25	.25	.25	.50	.00
door	handle	20	.50	.00	.25	.50	.50	.00	.00	.00	.50	.00
kitchen	sink	20	.00	.50	.25	.50	.00	.00	.25	.00	.50	.00
nut	cracker	20	.75	.00	.75	.75	.00	.50	.00	.25	.75	.00
pillow	talk	20	.50	.50	.50	.25	.50	.50	.50	.50	.25	.00
soul	mate	20	.50	1.0	.50	1.0	.00	.50	.50	.50	1.0	.00
world	wide	20	.50	.75	.75	.25	.25	.25	.25	.75	.25	.25
dragon	fly	21	.25	.75	.75	.75	.25	.25	.75	.75	.75	.00
screw	driver	22	.50	1.0	.75	.75	.25	.25	.75	.50	.75	.00
washing	machine	22	.50	.00	.25	.25	.00	.25	.00	.25	.25	.00
beer	glass	23	.00	.25	.00	.00	.00	.00	.25	.00	.00	.00
head	ache	23	.75	.50	.25	.50	.00	.75	.50	.00	.50	.00
bee	sting	24	.50	.50	.50	.50	.25	.25	.50	.25	.50	.00
blue	sky	24	.25	.50	.75	.75	.25	.00	.50	.25	.75	.00
heart	beat	24	.25	.25	.75	.00	.00	.00	.25	.00	.00	.00
heavy	weight	24	.25	.50	.00	.50	.25	.25	.25	.00	.50	.00
ice	cold	24	.50	.25	.25	.25	.75	.00	.25	.00	.25	.00
sofa	bed	24	.25	.75	1.0	1.0	.00	.25	.50	.50	1.0	.00

cover	up	25	.25	.50	.00	.25	.25	.25	.25	.00	.25	.00
dart	board	25	.75	.75	.50	.75	.50	.50	.50	.50	.75	.00
grape	fruit	26	.25	.25	.75	1.0	.25	.25	.00	.25	1.0	.00
senior	citizen	26	.75	.25	.25	.50	.00	.25	.25	.25	.50	.00
couch	potato	27	.75	.75	.75	1.0	.25	.75	.75	.50	1.0	.00
cling	film	28	.75	.75	.75	.75	.25	.25	.50	.00	.75	.00
cotton	wool	30	.50	1.0	.75	.75	.75	.25	1.0	.25	.75	.00
wedding	bell	30	.75	.25	.50	.50	.75	.00	.25	.25	.50	.00
comic	strip	31	.75	.00	.50	.50	.00	.50	.00	.25	.50	.00
humble	pie	32	1.0	.75	.75	.75	.00	.75	.75	.50	.50	.00
doll	house	33	.50	1.0	.50	.75	.25	.50	.25	.25	.75	.00
market	place	34	.50	.50	.75	.50	1.0	.50	.50	.50	.50	.25

Intentional

word	target	A ss	al1	al2	vl1	vl2	d	al1c	al2c	vl1c	vl2c	dc
baron	knight	9	.50	.50	.50	.75	.25	.50	.50	.25	.75	.00
greek	latin	9	.75	.50	.25	1.0	.00	.75	.50	.25	1.00	.00
share	give	9	.00	1.0	.25	1.0	.00	.00	1.0	.00	1.00	.00
excitement	fun	10	.25	.50	.25	1.0	.00	.25	.50	.25	1.00	.00
strict	severe	10	.00	.50	.00	.50	.00	.00	.25	.00	.50	.00
tablecloth	check	10	.50	.75	.25	.75	.00	.50	.75	.25	.50	.00
gate	fence	11	.25	1.0	.25	.75	.25	.25	.75	.00	.75	.00
steady	firm	11	.00	.00	.25	.50	.00	.00	.00	.25	.50	.00
authority	government	12	.25	1.0	.25	.75	.00	.25	1.0	.25	.75	.00
defence	attack	12	.50	.50	.50	1.0	.25	.25	.25	.25	1.00	.00
tragedy	comedy	12	1.0	.50	.50	.50	.00	.75	.50	.50	.25	.00
handbag	purse	13	.50	1.0	.50	1.0	.25	.50	.75	.25	1.00	.00
axe	chop	14	.00	.25	.25	1.0	.25	.00	.25	.00	1.00	.00
ham	egg	14	.50	.50	.75	1.0	.00	.50	.50	.75	1.00	.00
castle	sand	15	.25	.75	.50	.75	.00	.25	.50	.25	.75	.00
injustice	law	15	.75	.50	.50	.75	.25	.50	.50	.25	.50	.00
teeth	mouth	15	.50	.50	.25	1.0	.50	.00	.50	.00	1.00	.00
abrupt	short	16	.25	.25	.00	.75	.00	.00	.25	.00	.50	.00
drop	fall	16	.50	.75	.50	1.0	.50	.50	.75	.00	.50	.00
iron	steel	16	.25	1.0	.50	.75	.00	.00	1.0	.25	.75	.00
laundry	clothes	16	.00	.75	.25	.50	.25	.00	.75	.00	.50	.00
milk	cow	16	.50	.50	.50	.75	.00	.25	.50	.25	.75	.00
ambulance	hospital	17	.75	1.0	.75	1.0	.25	.25	1.0	.75	1.0	.00
anger	rage	17	.25	.75	.25	.75	.25	.00	.75	.00	.75	.00
bargain	sale	17	.25	1.0	.25	.75	.00	.00	.75	.00	.75	.00
desk	work	17	.25	.75	.00	.25	.00	.25	.75	.00	.00	.00
field	grass	17	.50	1.0	.50	1.0	.25	.00	.75	.00	1.0	.00
scarf	neck	18	.25	.50	.75	1.0	.00	.25	.50	.00	1.0	.00
couple	pair	19	.00	.75	.75	1.0	.50	.00	.75	.25	1.0	.00
disobey	naughty	19	.00	.25	.00	.75	.00	.00	.25	.00	.50	.00
dolphin	whale	19	.50	1.0	1.0	1.0	.50	.50	1.0	.50	1.0	.00
foot	shoe	19	.00	.25	.25	.75	.25	.00	.25	.00	.75	.25
margin	paper	19	.25	.50	.25	.75	.00	.00	.50	.25	.75	.00
prisoner	jail	19	.50	.75	.75	1.0	.00	.50	.75	.25	1.0	.00
failure	success	20	.75	.75	.50	.75	.00	.25	.75	.00	.75	.00
cellar	basement	21	.50	.50	.50	1.0	.25	.00	.25	.25	1.0	.00
realm	kingdom	21	.50	.75	.50	.25	.25	.25	.75	.25	.25	.00
season	spring	21	.25	1.0	.50	1.0	.75	.25	1.0	.25	1.0	.00
calorie	diet	22	.25	1.0	1.0	1.0	.00	.25	.75	.50	1.0	.00
boat	ship	23	.75	1.0	.75	1.0	.00	.50	1.0	.50	.75	.00
innocent	guilty	24	.75	1.0	1.0	1.0	.50	.25	.75	.50	.75	.25

athlete	runner	25	.50	.75	.75	1.0	.00	.50	.75	.25	.75	.00
pupil	teacher	26	.50	.50	.50	.75	.25	.25	.50	.25	.75	.00
rumour	gossip	26	1.0	.75	.75	1.0	.25	.50	.75	.25	1.0	.00
bun	oven	27	.50	1.0	.50	.75	.25	.25	1.0	.50	.50	.00
dirty	clean	27	.75	1.0	.75	1.0	.50	.25	.00	.50	.75	.00
fantasy	dream	27	.25	1.0	.25	1.0	.00	.00	1.0	.25	1.0	.00
honesty	truth	27	.25	1.0	.75	1.0	.50	.00	.75	.00	.75	.00
postcard	holiday	27	.00	.75	.75	1.0	.25	.00	.75	.50	1.0	.00
ashtray	cigarettes	28	1.0	1.0	1.0	1.0	.75	.75	1.0	.75	.75	.00
barrack	army	28	.50	.75	.75	1.0	.75	.50	.75	.75	1.0	.25
dig	hole	29	.50	.75	.00	.75	.25	.00	.50	.00	.75	.00
dish	plate	29	.50	.75	.00	.75	.00	.00	.50	.00	.75	.00
dove	peace	29	.50	1.0	.25	1.0	.25	.50	1.0	.25	1.0	.00
parcel	post	29	.25	1.0	.00	.50	.25	.25	1.0	.00	.50	.00
tenant	landlord	30	.50	1.0	1.0	1.0	.00	.25	1.0	.50	1.0	.00
basic	simple	31	.50	.75	.75	1.0	.50	.25	.75	.00	1.0	.00
cello	violin	31	1.0	1.0	1.0	1.0	.50	.50	1.0	1.0	.75	.00
fabric	cloth	33	.50	.75	.25	.75	.00	.50	.75	.00	.75	.00
plug	socket	35	1.0	1.0	.50	1.0	.25	.50	1.0	.25	.75	.00
magic	box	9	.25	.25	.00	.50	.00	.25	.25	.00	.50	.00
memory	loss	9	.25	.25	.25	.50	.00	.25	.25	.00	.50	.00
shop	front	9	.25	.50	.25	.50	.00	.25	.25	.00	.50	.00
business	man	10	.50	.50	.00	1.0	.25	.50	.50	.00	1.0	.00
gas	fire	10	.00	.50	.75	1.0	.00	.00	.50	.50	1.0	.00
pot	plant	10	.25	1.0	.50	.75	.25	.25	1.0	.00	.25	.00
baby	face	11	.50	.75	.25	1.0	.00	.50	.75	.25	1.0	.00
tooth	brush	11	.50	.75	.00	.50	.00	.50	.75	.00	.50	.00
ear	ring	12	.25	.00	.25	.75	.25	.00	.00	.00	.50	.00
leather	belt	12	.50	.75	.25	1.0	.00	.00	.75	.25	1.0	.00
run	away	12	.00	.50	.25	.75	.00	.00	.25	.25	.75	.00
blow	dry	13	.00	.25	1.0	1.0	.00	.00	.25	.25	1.0	.00
school	day	14	.00	.75	.00	.25	.00	.00	.75	.00	.25	.00
common	land	15	.50	.50	.00	.25	.00	.25	.50	.00	.00	.00
prime	number	15	.00	.00	.50	.50	.00	.00	.00	.25	.50	.00
sea	shore	15	.25	1.0	.50	.75	.00	.00	1.0	.25	.75	.00
skin	deep	15	.25	.75	.50	1.0	.50	.00	.75	.00	1.0	.00
tail	end	15	.50	.75	.25	1.0	.00	.00	.25	.00	.75	.00
building	site	16	.00	.75	.75	.75	.25	.00	.75	.25	.75	.00
eye	ball	16	.25	.50	.25	.75	.00	.00	.00	.25	.25	.00
lady	bird	16	.50	1.0	.25	.25	.25	.50	1.0	.00	.25	.00
power	station	16	.00	.00	.25	.25	.00	.00	.00	.25	.25	.00
trouble	maker	16	.25	.75	.50	1.0	.25	.25	.50	.25	.75	.00
copy	cat	17	.50	.50	.75	.50	.00	.50	.50	.50	.50	.00
theme	park	17	.75	1.0	1.0	.75	.00	.50	.75	.50	.50	.00
log	cabin	18	.00	.75	.25	1.0	.25	.00	.50	.00	1.0	.00
pop	music	18	1.0	1.0	.75	1.0	.50	.75	1.0	.25	1.0	.00
bear	hug	19	.50	.75	1.0	1.0	.50	.25	.75	.50	1.0	.00
bicycle	pump	19	.25	.75	.75	.00	.00	.25	.50	.50	.00	.00
coat	hanger	19	.25	.75	.25	1.0	.25	.00	.50	.25	1.0	.00
secret	garden	19	.50	.75	.50	.75	.00	.50	.50	.25	.50	.00
door	handle	20	.75	.50	1.0	.75	.50	.25	.50	.00	.75	.25
kitchen	sink	20	.75	.50	.25	.75	.25	.25	.25	.25	.75	.00
nut	cracker	20	1.0	1.0	.50	1.0	.00	.50	1.0	.50	.75	.00
pillow	talk	20	.50	.50	.50	1.0	.00	.25	.50	.25	.75	.00
soul	mate	20	.50	.75	.25	.50	.00	.00	.50	.00	.50	.00
world	wide	20	.50	.50	.75	1.0	.00	.25	.25	.00	1.0	.00
dragon	fly	21	.75	.75	.50	1.0	.00	.50	.75	.50	.75	.00
screw	driver	22	1.0	1.0	1.0	1.0	.75	.75	1.0	.25	1.0	.25
washing	machine	22	.50	1.0	.25	.50	.50	.50	1.0	.00	.00	.00

beer	glass	23	.00	.75	.00	.75	.25	.00	.25	.00	.75	.00
head	ache	23	.25	1.0	.25	.75	.25	.00	1.0	.00	.75	.00
bee	sting	24	.50	1.0	.75	1.0	.25	.50	.75	.50	1.0	.00
blue	sky	24	.50	.75	.00	.25	.25	.50	.75	.00	.25	.00
heart	beat	24	.00	.50	.50	.75	.25	.00	.00	.50	.75	.00
heavy	weight	24	.50	1.0	.25	.75	.00	.25	.50	.25	.50	.00
ice	cold	24	.00	1.0	.25	1.0	.00	.00	1.0	.25	1.0	.00
sofa	bed	24	.50	.50	.50	1.0	.50	.25	.50	.50	1.0	.00
cover	up	25	.25	.25	.75	1.0	.00	.00	.00	.00	1.0	.00
dart	board	25	.75	1.0	1.0	1.0	.75	.50	1.0	.50	.25	.00
grape	fruit	26	.75	.75	.25	1.0	.50	.75	.75	.25	1.0	.00
senior	citizen	26	.75	.75	.50	1.0	.25	.50	.75	.25	1.0	.00
couch	potato	27	.50	.75	.50	1.0	.50	.25	.75	.50	1.0	.00
cling	film	28	1.0	.75	1.0	1.0	1.0	.50	.75	1.0	1.0	.00
cotton	wool	30	.75	1.0	.75	1.0	.75	.75	1.0	.25	.75	.00
wedding	bell	30	.50	1.0	.75	1.0	.25	.50	1.0	.25	1.0	.00
comic	strip	31	.25	1.0	.25	.50	.25	.00	1.0	.00	.25	.00
humble	pie	32	.75	.75	.75	1.0	.00	.00	.75	.75	1.0	.00
doll	house	33	.75	1.0	1.0	1.0	.75	.00	.75	.50	1.0	.00
market	place	34	1.0	.75	1.0	.50	.75	.00	.75	.50	.25	.25

Appedix 6.6 2x2x2x2 mixed ANOVA from Experiment 6

Experiment 6. A 2x2x2x2 mixed ANOVA with test instructions (inclusion vs. incidental),as the between participants variable and three within participants variables of depth of processing [DOP] (semantic vs. phonemic), association type [ASSOC] (two-word phrases vs. weak associates) and modality (visual vs. auditory) on corrected scores.

Source of Variation	SS	DF	MS	F	Sig of F
Tests of Between-Subjects Effects.					
WITHIN+RESIDUAL	4.01	38	.11		
TEST	3.50	1	3.50	33.16	.000
Tests involving 'MODALITY' Within-Subject Effect.					
WITHIN+RESIDUAL	.82	38	.02		
MODALITY	.27	1	.27	12.58	.001
TEST BY MODALITY	.01	1	.01	.57	.457
Tests involving 'DOP' Within-Subject Effect.					
WITHIN+RESIDUAL	1.41	38	.04		
DOP	1.01	1	1.01	27.32	.000
TEST BY DOP	.00	1	.00	.11	.747
Tests involving 'ASSOC' Within-Subject Effect.					
WITHIN+RESIDUAL	.82	38	.02		
ASSOC	.99	1	.99	45.83	.000
TEST BY ASSOC	.12	1	.12	5.68	.022
Tests involving 'MODALITY BY DOP' Within-Subject Effect.					
WITHIN+RESIDUAL	1.60	38	.04		
MODALITY BY DOP	.35	1	.35	8.23	.007
TEST BY MODALITY BY DOP	.85	1	.85	20.16	.000
Tests involving 'MODALITY BY ASSOC' Within-Subject Effect.					
WITHIN+RESIDUAL	1.51	38	.04		
MODALITY BY ASSOC	.65	1	.65	16.30	.000
TEST BY MODALITY BY ASSOC	.77	1	.77	19.42	.000
Tests involving 'DOP BY ASSOC' Within-Subject Effect.					
WITHIN+RESIDUAL	.62	38	.02		
DOP BY ASSOC	.10	1	.10	6.20	.017
TEST BY DOP BY ASSOC	.00	1	.00	.08	.775
Tests involving 'MODALITY BY DOP BY ASSOC' Within-Subject Effect.					
WITHIN+RESIDUAL	.60	38	.02		
MODALITY BY DOP BY A SSOC	.00	1	.00	.28	.597
TEST BY MODALITY BY DOP BY ASSOC	.00	1	.00	.01	.944