Memory Complaints and Objective Memory Performance in First Pregnancy

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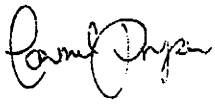
Declaration

This thesis is my own work, and has not been submitted elsewhere. All sources have been acknowledged.



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Abstract

Despite the finding that women report memory problems in pregnancy, there is little evidence for an objective memory deficit on retrospective-type tests, such as recall, recognition, and priming. Two other areas, prospective memory and working memory, have not been investigated to date. The aims of this study were to examine the nature of memory complaints in pregnancy, and three possible origins of objective memory deficits: (i) inefficient self-initiated retrieval processes as revealed by poor prospective memory; (ii) inefficient working memory; and (iii) a selective memory deficit specific to non-pregnancy material (i.e., a content specificity effect). These aims were investigated using a memory perception questionnaire, and objective tests of prospective memory, working memory, and recognition. In addition, this investigation addressed the possibility that subjective or objective memory deficits may be attributable to factors other than pregnancy, including depression, anxiety, and sleep loss.

Compared to non-pregnant women (n=30) of the same age and educational level, pregnant women (n=30) perceived that deterioration had occurred in all areas of memory that were assessed, including retrospective memory, prospective memory, and working memory. In addition, informants of the women confirmed this finding, suggesting that the women's reports were valid. In pregnant women, depressive symptoms, as measured by a non-somatic cognitive scale, were associated with memory complaints. However, pregnant women were no more depressed than the controls.

In contrast to their reports of memory deficits, pregnant women failed to show any deficits on the objective memory tests. However, on the working memory task, pregnant women showed marginally better memory for pregnancy-related material, and marginally worse memory for non-pregnancy material than did the controls. Strikingly, on the recognition test of incidentally learnt words, pregnant women had better memory for both pregnancy-related and neutral words. Generally, across the three objective tests, memory performance was not related to depression, anxiety, sleep loss, or perceived memory functioning.

There was little support for any of the proposed origins of objective memory deficits in pregnancy. Specifically, there was no evidence for the notions of inefficient self-initiated retrieval or inefficient working memory, although there was some support for a content specific memory effect as suggested by the working memory task. However, the finding that pregnant women had superior recognition memory, independent of whether the material's content was pregnancy-related or not, was not consistent with this effect.

In conclusion, the discrepancy between subjective and objective measures in pregnancy found by other studies for retrospective memory was confirmed for tests of prospective memory and working memory. One interpretation of this discrepancy is that a genuine objective memory deficit does exist, but that it has not been captured by the memory tests used to date. A more viable interpretation is that there is no objective memory deficit in pregnancy. The memory complaints made by pregnant women may reflect non-memory factors, rather than an objective deficit per se. The possibility needs to be investigated that negative beliefs about memory change in pregnancy may underlie such complaints.

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Chapter 1

Pregnancy and Cognitive Functioning

1.0 Introduction

Reports of increased difficulties with memory and concentration during pregnancy have generated interest in the study of cognitive deficits in pregnant women. Much of this research, carried out over the past decade, indicates that women perceive that their cognitive skills, particularly their memories, have deteriorated during pregnancy. Despite these perceptions, the evidence of an objective cognitive deficit from psychometric testing of memory and attention is, at best, mixed.

Although conclusive evidence for objective cognitive deficits in pregnancy is lacking, the circumstances of pregnancy certainly give plausibility to the notion that cognitive deficits might be present in pregnancy. Pregnancy, especially first pregnancy, is associated with many psychological and physiological changes including major adjustments to lifestyle, increases in depression and anxiety, enormous fluctuations in hormones, and sleep disruption. Such changes have been associated with deterioration in cognitive functioning in non-pregnant individuals. Indeed, both psychological and hormonal processes have been proposed as the underlying mechanisms for objective cognitive deficits in pregnancy.

The goal of this chapter is to assess the evidence for subjective and objective cognitive deficits in pregnancy. In addition, this analysis reviews a number of potential psychological and hormonal explanations for such deficits. The chapter concludes with an outline of the areas that will be assessed in this thesis. These focus on possible bases for objective memory deficits.

1.1 Perceptions versus Performance

This section reviews the findings of studies investigating (1) women's perceptions of cognitive functioning during pregnancy, and (2) women's performance on cognitive tasks during pregnancy. This review reveals a major discrepancy between women's perceptions of memory deterioration and their objective performance on a range of memory tests. It finds that women report poorer performance, but that the objective evidence for this deficit is weak. Possible explanations for this discrepancy are discussed.

1.1.1 Perceptions of Cognitive Deficits in Pregnancy

There have been twelve studies reporting on women's perceptions of their cognitive functioning in pregnancy. Memory has been the most widely assessed area, but several studies have measured other cognitive areas, such as concentration and attention. Most of these studies indicate that the majority of women perceive that their performance in these cognitive areas has deteriorated during pregnancy.

Six of the studies have investigated women's perceptions of memory. This has typically been assessed by a single self-report questionnaire item on some aspect of memory functioning. Poser, Kassirer, and Peyser (1986) found that 81% of women reported having problems with forgetfulness during pregnancy (n=51). However, their reports were retrospective (with some reports relating to pregnancies that had occurred 12 months earlier), and the study lacked a baseline measurement or control group. Condon & Ball (1989) found that pregnant women (n=90) rated that their memory was worse during pregnancy than it had previously been. Informants of the women also perceived that their memory had deteriorated. Parsons and Redman (1991) found that 64% of women, who had recently delivered their first child, retrospectively reported that they had greater difficulties with remembering during pregnancy than usual (n=236). They also found that 68% of currently pregnant women (n=50) reported greater difficulties with recall and memory since becoming pregnant.

Brindle, Brown, Brown, Griffith, and Turner (1991) found that 59% (n=32) of pregnant women reported a decline from their normal levels of memory functioning. Few non-pregnant women (called *controls* herein) reported a decline (11%, n=9). The mean ratings also showed that pregnant women reported significantly greater decline. Sharp, Brindle, Brown, and Turner (1993) found that 81% (n=48) of pregnant women perceived that their memory had declined from normal levels, whereas only 16% of controls also did (n=19). Again, the mean ratings indicated that pregnant women reported greater decline. Christensen, Poyser, Pollitt, and Cubis (in press) found that, although pregnant women (n=52) did not report more

current memory problems than did controls (n=35), the pregnant women rated that their memory had been better 6 months earlier. Informants also confirmed these reports. A limitation of these general subjective measures is that they are uninformative about possible impairments in specific areas of memory.

As with memory, women also perceive deterioration to occur in concentration and attention during pregnancy. Parsons and Redman (1991) found that 50% of new mothers retrospectively perceived greater problems with concentration during pregnancy than usual, and 60% perceived greater problems with absentmindedness. They also found that 54% of currently pregnant women perceived greater problems with concentration and attention, and 52% with absentmindedness. Condon and Ball (1989) reported that currently pregnant women, and their informants, perceived that they had more problems with concentration during pregnancy relative to a previous non-pregnant state, as well as an increase in problems with 'drifting off', 'being easily distracted', 'losing track when talking', and 'daydreaming'. Finally, Poser et al. (1986) found that 57% of women reported having difficulties with reading during pregnancy, possibly reflecting a concentration or memory problem. They also found that relatively few women reported increases in confusion (29%) or disorientation (14%). As noted earlier, this study did not have a baseline measurement or a control group.

Several studies have investigated women's perceptions of cognitive functioning during pregnancy using combined measures of memory, attention, and other cognitive skills. Condon and Ball (1989) found that 50% of currently pregnant

women reported 'cognitive decline' during pregnancy. This was measured by a generated 17-item questionnaire comparing pregnancy with a previous non-pregnant status, and included a range of items relating to memory and concentration. Informants who completed a similar questionnaire about the pregnant women also perceived the women to have suffered cognitive decline, although to a lesser degree than the women themselves did. Similarly, Condon (1987) found that 48% of pregnant women (n=165) perceived that their 'memory and concentration' had deteriorated in comparison to a non-pregnant state. A longitudinal study by Schneider (1989) followed a group of pregnant women (n=33) each week from conception until the end of pregnancy, collecting reports of their problems with concentration, memory, and 'ability to comprehend or understand something'. Although the study noted that 91% of women reported lapses in memory and concentration throughout pregnancy, it failed to measure this rate against a baseline measurement or a control group. A general problem with these combined scores is that they may mask problems in specific domains of memory or cognition.

While most studies of cognitive functioning in pregnancy report a perceived deterioration, a few studies have failed to find these effects. A study by Jarrahi-Zadeh, Kane, Van de Castlf, Lachenbruch, and Ewing (1969) revealed that few pregnant women (12%) (n=86) reported 'mental fogginess', a score which reflected ratings of 'foggy or unclear thinking', 'ability to concentrate', and 'change in memory functioning'. Furthermore, there was no change in the level of mental fogginess between pregnancy and a baseline rating at 3 days postpartum, although

the baseline rating may have been inflated by the effects of hormonal and emotional fluctuations following childbirth.

Condon, Derham, and Kneebone (1991) examined self-reported cognitive failures in a group of women (n=38) during pregnancy and again 8 weeks postpartum (baseline) using the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, Fitzgerald, & Parkes, 1982), which scores for failures of perception, memory, and motor function in everyday activities. They found that women's rate of cognitive failures did not change between pregnancy and the baseline testing. However, it was noted that the failure to reveal a deficit could have been due to the presence of a deficit at both interviews, or to the insensitivity of the questionnaire to the type of cognitive changes that occur during pregnancy. Also using the CFQ, Gross and Pattison (1994) failed to find any differences between pregnant women (n=31) and controls (n=17). Finally, Lips (1982) compared pregnant women (n=108) with their husbands (n=95), and also with non-pregnant women (n=151) and their husbands (n=116) on their self-perceptions of general performance, a score which combined concentration, efficiency, work performance, and motor coordination. Surprisingly, the pregnant women rated their performance as better than non-pregnant women and their husbands, although this may have been confounded by age differences which showed that the pregnant women were significantly younger.

Although there have been no systematic studies on whether perceived cognitive deterioration is associated with trimester of pregnancy or parity, cognitive deterioration is widely reported by pregnant women under a variety of circumstances.

For example, women have reported cognitive deficits in first, second, and third trimesters (e.g., Brindle et al., 1991; Christensen et al., in press; Condon & Ball, 1989; Sharp et al., 1993). Women have also reported cognitive deficits to have occurred in their first pregnancy (Brindle et al., 1991; Christensen et al., in press; Condon & Ball, 1989; Sharp et al., 1993), and in subsequent pregnancies (Brindle et al., 1991; Condon & Ball, 1989; Sharp et al., 1993). Although Brindle et al. (1991) reported that perceived deterioration was highest among primiparous women, and particularly in second trimester (83%, n=6), these effects have not been supported by other studies (Condon & Ball, 1989; Sharp et al., 1993). Overall, the evidence points to no relationship between perceived cognitive deficits and trimester or parity.

An important methodological shortcoming of most of these subjective studies has been the lack of control for anxiety and depressive symptoms. These symptoms, which are known to increase during pregnancy (e.g., Ballinger, 1982; Condon, 1987; Condon et al., 1991; O'Hara, Zekoski, Phillipps & Wright, 1990), may contribute to women's cognitive complaints in pregnancy. Other research on non-pregnant individuals has shown that anxiety and depression are associated with cognitive complaints, even in the absence of any objective cognitive deficit (e.g., Martin & Jones, 1984; O'Hara, Hinrichs, Kohout, Wallace, & Lemke, 1986; Popkin, Gallagher, Thompson, & Moore, 1982; West, Boatwright & Schleser, 1984). While it seems plausible that cognitive complaints during pregnancy may be related to affective symptoms, few studies have investigated this possibility.

Summary

In summary, it is clear that there is the perception of cognitive deterioration during pregnancy in a substantial proportion of women. While most of the studies have found that women report memory problems in pregnancy, a few studies have also found that women report deficits in concentration and attention. Although there are methodological problems in some of these studies, these deficits have been confirmed by informants, suggesting that the effect may be genuine. Whether or not this perceived deficit corresponds to an actual performance deficit on objective tests will be discussed in the next section.

1.1.2 Cognitive Performance in Pregnancy

Despite the evidence from women's self-reports of perceived cognitive deficits during pregnancy, there is a lack of robust evidence of such deficits on objective tests. In considering the studies on the relationship between pregnancy and objective cognitive performance, the objective tests are divided into the following categories: explicit memory, implicit memory, prospective memory, working memory, and other cognitive tests (e.g., attention, speed).

Explicit memory. Explicit memory describes a type of memory that is "revealed when performance on a task requires conscious recollection of previous experiences" (Graf & Schacter, 1985, p.501). It refers to the type of memory tested by many traditional long-term retrospective memory tests, such as free recall, cued recall, and recognition. Typically, participants would study a list of words, and later be given explicit instructions to recall the words from that list, or to correctly identify

words from the list as in a recognition test. There is mixed evidence for a deficit on explicit memory tests during pregnancy. Some of the studies using explicit memory tests have also used intentional and incidental learning conditions. An intentional learning condition is one in which participant are given definite instructions to learn the words to be studied. By contrast, an incidental learning condition is one in which no instructions are given that a memory test will be forthcoming. Hence, any learning of the material is incidental.

Silber, Almkvist, Larsson, and Uvnäs-Moberg (1990) assessed a group of pregnant women (n=18) on four explicit memory tests both during pregnancy, and also in the postpartum period (first week, 3, 6, and 12 months). Controls were also assessed at similar intervals (n=19). On a paired-associate learning test, pregnant women performed worse during pregnancy than at 6 months postpartum, whereas the performance of controls was unchanged over a similar period. This test required participants to study pairs of meaningless syllables, and then immediately recall one member of the pair when cued with the other. Notably, the difference observed at 6 months was not present at the first week after delivery, three months postpartum, or 12 months postpartum. There were no differences between pregnant women and controls on any of the other three tasks: a recall test, which required the participants to recall of pairs of syllables from the paired-associate learning test; and two visual recognition tests, which required the participants to recognise a previously studied geometric shape or pattern amongst a set of distractor shapes or patterns.

Condon et al. (1991) compared pregnant women (n=35) and controls (n=15) on Buschke's Selective Reminding Test (SRT). The SRT resembles a recall test, but also involves the selective presentation on each study trial of only those items which were not recalled on the immediately preceding test (Buschke, 1973). Pregnant women were tested during the third trimester of pregnancy and, for baseline, at 8 weeks postpartum. Controls were tested twice at a similar interval. Compared to controls, pregnant women showed poor performance on two indices of the SRT (total recall and long-term retrieval, but not long-term storage) during pregnancy. However, a deficit was also observed at baseline, which suggests that there may have been differences between the groups that were not related to pregnancy. Alternatively, a different set of factors, such as those associated with the major adjustment after birth, may have maintained poor performance in the postpartum.

Sharp et al. (1993) compared pregnant women (n=48) and controls (n=19) on a variety of recall and recognition tests, where the learning conditions were either incidental or intentional. Pregnant women showed impairment on a word recall test following incidental learning. Furthermore, multiparous women (n=26), but not primiparous women (n=24), showed impairment on a word recall test when the learning was intentional. No differences were found for the recall of objects (with intentional learning) or for tests of recognition (word recognition with both incidental and intentional learning; object recognition with intentional learning).

Eidelman, Hoffman, and Kaitz (1993) compared high-risk pregnant women who were attending hospital (n=15) and controls (n=20) on Wechsler's Logical

Memory and Visual Reproduction tests. Pregnant women were impaired on the Logical Memory test which required participants to listen to a story and to recall as many details as possible. In contrast, they did not differ from controls on the Visual Reproduction Test. This required participants to study abstract figures and later draw them from memory. It is noted that these women with high-risk pregnancies may have had higher than normal levels of anxiety and depression. This factor may be responsible for the deficits observed, rather than pregnancy per se. The role of such performance-related factors will be described in more detail in a later section.

Each of the explicit memory studies considered so far report a pregnancy-related deficit on at least one measure of explicit memory. In contrast, Brindle et al. (1991) showed that pregnant women's performance (n=32) did not differ from that of controls (n=9) on three explicit memory tests, including the recall of categorised words and household objects, and the recognition of faces. However, the control group was significantly older than the pregnant group, and this may have contributed to the lack of differences. Christensen et al. (in press) found no differences between pregnant women (n=52) and controls (n=35) on a four word recall tests with incidental and intentional learning instructions, a word recall test cued with the stems of studied words, and a recognition test following incidental learning.

As part of a post-hoc analysis of data from an epidemiological survey of health and well-being, Huppert and Whittington (1997) compared pregnant women (n>100) and controls (n>2000) on an incidental recall test of common food names. There were no differences between these groups. However, pregnant women with

mood symptoms had impaired memory compared to controls. They also noted that no differences were found between testing at pregnancy and postpartum (>12 months), or between pre-conception and pregnancy, compared to controls tested at similar intervals.

In sum, four of the seven studies report a deficit in pregnancy on one or more tasks. Overall, the evidence seems inconsistent, and in many cases is complicated by methodological problems and potentially confounded by other performance-related factors, such as anxiety and depression.

Implicit memory. Implicit memory tests are those in which the participant's knowledge is tested indirectly, through methods that do not involve conscious recollection of a previous experience (for review, see Schacter, 1987). In a typical test of implicit memory, such as a word-stem completion task, the participant views a study list of words, and shortly afterwards (e.g., 2-3 mins) is asked to complete half-words or stems to make the first word that comes to mind. (e.g., studied word: MOUSE; stem: MOU__). Unlike explicit memory tests, no reference is made to the studied list by the experimenter.

Evidence for a pregnancy-related deficit on implicit memory tests has been provided by two studies. Brindle et al. (1991) found that primiparous women, but not multiparous women, showed impaired performance when compared to controls, but as noted earlier, this finding was confounded by age differences. Sharp et al. (1993)

also found that pregnant women showed impaired performance on two implicit memory tests compared to non-pregnant controls using 'perceptual' and 'conceptual' cues at test. A word-stem completion task was used as the perceptual test because, in this test, the cue is similar in visual appearance to the studied word. The priming of the pronunciation of homographs was used as the conceptual test. Here, the cue shares semantic features with the target. In this test, women studied a list of words and were later asked to read aloud a different set of words that could be pronounced in two ways corresponding to two different meanings. One of those meanings had been primed by the studied list (e.g., studied word: CRY; word tested: TEAR, pronounced either 'teer' as in "a tear drop" or 'tair' as in " to tear up some paper").

In contrast to these two studies, the unpublished studies of Casey, Huntsdale, Angus, & Janes (1998) and Janes, Casey, Huntsdale, & Angus (1998) have failed to find any deficits in a combined group of pregnant women and new mothers (n=40, n=66, respectively) compared to controls (n=20, n=45, respectively). These studies also used word-stem completion tests with perceptual cues. However, given that a combined group was used, it is not clear that the finding is related to pregnancy.

Given the possibility that implicit memory tests may be contaminated by the use of explicit memory, Christensen et al. (in press) measured performance on a word-stem completion task using a method called 'process dissociation', which is designed to overcome this possible contamination. No differences were found between pregnant women and controls on the two word-stem completion tasks. In both tasks, participants studied a list of words for a memory test, but the instructions

at test differed. In the 'inclusion' task, participants were asked to complete the stems with words from the studied list, whereas in the 'exclusion' task, participants were asked to complete the stems with any word other than ones seen in the list. In sum, the evidence from the two published studies of pregnant women suggests that performance on implicit memory tests may be impaired during pregnancy, although replication of this effect is required.

Prospective memory. Prospective memory refers to remembering to perform an action in the future (for reviews, see Harris, 1984; Morris, 1992). Many everyday situations, such as remembering to attend a meeting or a doctor's appointment, involve prospective memory. Prospective memory can also be distinguished from retrospective memory in that it does not have obvious external cues to aid remembering (see Kvavilashvili, 1987).

Little is known about how pregnancy affects performance on prospective memory tasks. Casey et al. (1998) compared performance of a combined group of pregnant women and new mothers (n=66) with controls (n=45) on a task which required participants to remember to telephone the experimenter at the end of a week (both with and without the aid of reminder cards). Findings showed there were no performance differences between the two groups. It is noted that, in this type of naturalistic prospective memory task, it is difficult to determine whether the failure to remember the task is related to memory or another factor, such as a lack of motivation, because there is relatively little control over the participant's behaviour (Kvavilashvili, 1992). Furthermore, the inclusion of new mothers in the sample

obscures the results with respect to pregnant women. No other studies have investigated the effects of pregnancy on prospective memory performance.

Working memory. Working memory is defined as the short-term simultaneous storage and processing of information in complex cognitive tasks such as mental arithmetic, language comprehension, problem-solving, learning, and reasoning (for reviews, see Baddeley, 1986; Hitch, 1984). Its dual functions of storage and processing distinguish it from other forms of memory, such as explicit memory, which only requires storage (Baddeley, 1986; Daneman & Carpenter, 1980; Salthouse, 1990). Working memory is commonly measured by tests such as backward digit span and reading span. A typical backward digit span test requires participants to learn progressively longer sets of digits and recall them in the reverse order to that in which they were presented. A typical reading span task (Daneman & Carpenter, 1980) requires participants to read progressively longer sets of sentences aloud and learn the last word of each sentence for a later memory test.

The only data on working memory performance in pregnancy are from two unpublished studies (Casey et al., 1998; Janes et al., 1998). Janes et al. (1998) found that a combined group of pregnant women and new mothers (n=40) performed worse than controls (n=20) on a backward digit span test, but not on a reading span test. Pregnant women (primigravid) also showed impaired backward digit span when examined separately (n=20) (P. Casey, personal communication, October 22, 1998). In contrast, Casey et al. (1998) failed to find differences between a combined group of pregnant women and new mothers (n=66) and controls (n=45) on a backward digit

span test and a reading span test. Similarly, pregnant women (primigravid) (n=22) also showed unimpaired backward digit span when compared to 'never been pregnant' women (n=23) (P. Casey, personal communication, October 22, 1998). With only two conflicting studies in this area, no conclusions can be drawn about changes that might occur in working memory performance during pregnancy.

Other cognitive tests. A number of studies have investigated the effect of pregnancy on cognitive measures other than memory, such as attention and speed. These findings have been inconsistent. Silber et al. (1990) examined performance of pregnant women on a simple reaction time task that required participants to respond to a visual stimulus presented at varying intervals. These women were tested once during pregnancy, and then on four occasions during the postpartum period. A group of controls were also tested at similar intervals. Pregnant women showed slower reaction times during pregnancy than at 6 months postpartum, while controls showed faster reaction times at first testing occasion than at the later 6 month testing.

Condon et al. (1991) compared pregnant women with controls on the Stroop test, but failed to find any differences in speed on the three Stroop tasks. These tasks included: (i) reading aloud a series of words which are also colour names; (ii) naming aloud the ink colour of a series of bars; and (iii) a colour-word interference task in which participants name the ink colour of written colour-words (e.g., responding "red" to the word "blue" written in red ink.). Christensen et al. (in press) failed to find differences in speed between pregnant women and controls on a dot-probe attention task. This required participants to respond to target dots that appeared

within a list of words. The study also failed to find group differences on a test of everyday attention in which participants were timed on a task of searching a listing of telephone numbers for specific symbols.

Brinsmead, Smith, Singh, Lewin, and Owens (1985) measured 'cognitive performance' of pregnant women in their third trimester (n=19) and then again after childbirth in the first 4 days postpartum. Women completed a forward digit span test. This requires participants to listen to increasingly longer sets of digits for recall at the end of a trial until the participant fails to recall all digits perfectly. They also completed a modified version of Raven's progressive matrices. In this test, participants are presented with an incomplete design to be completed from six alternatives. On a combined score for the two tests, performance did not change between pregnancy and postpartum, although, as noted earlier, the postpartum test was confounded by birth-related emotional and hormonal fluctuations.

Jarrahi-Zadeh et al. (1969) compared pregnant women (n=86) with controls (n=21) on a Porteous Maze test and a Trail-making test. Both are timed drawing tests; the former requires participants to trace a path to exit a maze, and the latter requires subjects to connect a sequence of points. The findings revealed that pregnant women were slower than controls on the Mazes, but not on Trail-making. However, these results are complicated by the presence of depression in the pregnant women, which is also known to contribute to poor cognitive performance.

Summary of objective performance on cognitive tests

Overall, these findings do not strongly support the proposition that there is an objective cognitive deficit in pregnancy. Many of the findings are inconsistent. For example, there is mixed evidence for a deficit on explicit memory tests (paired-associate learning test: Silber et al., 1990; SRT: Condon et al., 1991; recall: Eidelman et al., 1993; Sharp et al., 1993; cf. recall, recognition: Brindle et al., 1991; Christensen et al., in press; Condon et al., 1991; Silber et al., 1990). The evidence is also mixed for deficits on attention-type tests (Silber et al., 1990; cf. Christensen et al., in press; Condon et al., 1991), and backward digit span (P. Casey, personal communication, October 22, 1998).

The few results pertaining to trimester and parity are also inconsistent. Brindle et al. (1991) found greater impairments in second-trimester women compared to first- and third- trimester women on an implicit memory test. Sharp et al. (1993) found that third-trimester women had worse incidental word recall than did second-trimester women. On other cognitive tests, there is no evidence of a trimester effect (Brindle et al., 1991; Christensen et al., in press; Sharp et al., 1993).

There is also mixed evidence for a relationship between parity and memory performance. Brindle et al. (1991) found that primigravidae women (n=15) had impaired performance on an implicit memory test compared to controls, whereas multigravidae women (n=17) did not. In contrast, Sharp et al. (1993) found that multigravidae women (n=26), but not primigravidae women (n=22), were impaired on an explicit verbal recall test compared to controls. Furthermore, the multigravidae

showed greater impairments than the primigravidae on an incidental word recall test. Overall, while these findings suggest that there is no effect of trimester and parity on memory performance, there is insufficient systematic examination of these relationships.

Methodological shortcomings of previous studies

The interpretation of these pregnancy-cognition findings must be considered in the context of methodological shortcomings. Mood changes and sleep loss are two factors that are commonly found in pregnancy, and which are also known to impair cognitive performance in non-pregnant individuals, but have not been adequately considered in past pregnancy studies. It is possible that one or both of these factors may have contributed to the outcome of cognitive tests independent of any pregnancy effect. These and other methodological limitations of previous studies are discussed below.

Mood symptoms. As noted earlier, pregnancy is associated with increases in depressive and anxiety symptoms. Furthermore, there is substantial evidence that depression and anxiety are associated with cognitive deficits in non-pregnant individuals (for reviews, see Eysenck, 1992; Johnson & Magaro, 1987; Williams, Watts, MacLeod, & Mathews, 1988).

With specific regard to pregnancy, three studies have suggested that mood symptoms may be related to cognitive deterioration. First, Jarrahi-Zadeh et al. (1969) noted that the degree of impairment on cognitive tests was correlated to the level of

emotional disturbance during pregnancy. Second, data from a British survey of health and lifestyle found that pregnant women with adverse mood changes, but not other pregnant women, showed poor recall of incidentally learnt words compared to controls (Huppert & Whittington, 1997). Third, Brindle et al. (1991) found a correlation between self-rated anxiety and performance on a word-stem completion test in which pregnancy-related deficits were found, although there were no overall differences between pregnant and control groups on anxiety levels.

In contrast, a study by Sharp et al. (1993) failed to find a relationship between self-ratings of anxiety and memory deficits in pregnancy. Further, Condon et al. (1991) found that women reported higher levels of tension and depression on the Profile of Mood States (McNair, Lorr, & Droppleman, 1971) during pregnancy than at a later postpartum test. However, these symptoms were not associated with performance on objective tests (i.e., Stroop test, SRT). In a study of pregnant women and controls with equivalent levels of anxiety and depression (excluding somatic symptoms), Christensen et al. (in press) found no evidence of poor performance among the pregnant women. Most other studies have failed to control for depression (Brindle et al., 1991; Eidelman et al., 1993; Jarrahi-Zadeh et al., 1969; Sharp et al., 1993; Silber et al., 1990), and anxiety (Eidelman et al., 1993; Silber et al., 1990). Thus, for these studies, the possibility remains that higher levels of mood symptoms in pregnant women may have been responsible for the observed objective deficits.

Sleep loss. Another potentially confounding variable is sleep loss. In pregnancy, women consistently report sleep disturbance, fatigue, and tiredness

(Condon et al., 1991; Cox, Connor, & Kendell, 1982; Janes et al., 1998; Jarrahi-Zadeh et al., 1969; Smith et al., 1990). In non-pregnant individuals, there is clear evidence that cognitive performance, at least on some objective tests, deteriorates as a consequence of severe sleep deprivation, such as several days without any sleep (e.g., Angus, Heslegrave, & Myles, 1985; Babkoff, Mikulincer, Caspy, Kempinski, & Sing, 1988; Englund, Ryman, Naitoh, & Hodgdon, 1985; Linde & Bergstrom, 1992; for a meta-analysis, see Pilcher & Huffcutt, 1996). However, the effects of partial sleep loss (<5 hours sleep in 24 hours) on cognitive performance are mixed (e.g., Haslam, 1985; Pilcher & Huffcutt, 1996). While pregnancy-related sleep loss is more likely to resemble partial sleep loss, few studies have considered the impact of this variable.

Two studies have reported that perceived sleep loss in a combined group of pregnant women and new mothers was *not* related to their memory performance (Casey et al., 1998; Janes et al., 1998). Rather, it was related to their self-reports of memory deterioration. However, given the use of the combined group, this effect may not be due to pregnancy. Condon et al. (1991) found that pregnant women's ratings of fatigue were not related to their cognitive performance, despite their reports of greater fatigue in pregnancy than at 8 weeks postpartum. In pregnant women and controls of equivalent fatigue levels, Christensen et al. (in press) failed to find any evidence of a pregnancy-related deficit on tests of recall and recognition. Overall, given the lack of data, the possibility that sleep loss might contribute to poor cognitive performance in pregnancy has not been ruled out.

Other limitations. There are a number of other methodological limitations in the studies described. Differences in age between pregnant women and controls may have been responsible for the deficits observed in studies where age has not been controlled (e.g., Brindle et al., 1991). In addition, the use of a post-birth interview as baseline in the longitudinal studies (e.g., Condon et al., 1991; Jarrahi -Zadeh et al., 1969) may be confounded because of the effects of emotional and hormonal factors. The possibility that pregnancy-related hormonal fluctuations may have some effect on cognitive performance will be discussed in a later section. The findings of several pregnancy studies are also limited by small sample sizes (Brindle et al., 1991; Eidelman et al., 1993), and by the lack of a control group (Schneider, 1989). Although Schneider (1989) reported that cognitive performance improved as pregnancy progressed in comparison to a baseline testing prior to conception, this may reflect practice effects. Christensen et al. (in press) have also noted that few of the studies have adequate statistical power to reveal small deficits.

Conclusion

The evidence for an objective cognitive deficit in pregnancy is weak. In addition, the database itself is poor as few studies are without methodological limitations. Clearly, there is a need to evaluate the possibility of objective cognitive deficits in pregnancy more carefully. While objective cognitive testing has concentrated on retrospective memory, particularly explicit memory, other areas of memory performance, such as prospective memory and working memory, have largely been ignored.

1.1.3 Discrepancy between Perceptions and Performance

In earlier sections, I have reviewed studies on subjective and objective cognitive functioning in pregnancy. These have found clear evidence for a subjective cognitive deficit, but less clear evidence for an objective deficit. The majority of these studies have examined memory functioning. Three studies that have assessed *both* subjective and objective memory deficits in pregnant women are summarised in Table 1. These studies also find a discrepancy between subjective and objective memory measures. As indicated in the separate reviews of subjective and objective measures, the pregnant women report memory deficits, but there is little evidence of a deficit in their performance on objective memory tests. Clearly, there is a major discrepancy between what pregnant women *say* about their memory functioning and how they *perform* on memory tests.

There are two possible explanations for this discrepancy. One is that there is no objective memory deficit in pregnancy (memory complaints reflect non-memory factors). These factors include emotional and cognitive changes and/or women's perceptions of social roles. The other is that there is a genuine objective memory deficit in pregnancy, but due to methodological limitations this has not been captured by the objective measures used to date. This may be because the tests have failed to target the specific areas in which memory deficits occur. A further discussion of this issue is raised in the next section.

Table 1

Studies with both subjective and objective memory measures

	Subjective Memory Ratings	Objective Memory Tests		Deficit on both measures?
Source	Results	Measure	Results	
Brindle et al. (1991)	Pregnant women report greater memory deterioration than controls	Word-stem completion	Pregnants impaired relative to controls	Yes[a]
		Recall & recognition tests	No group differences	No
Sharp et al. (1993)	Pregnant women report greater memory deterioration than controls	Word-stem completion, priming pronunciation, recall (categorised words, word-stem words)	Pregnants impaired relative to controls (Multi only for category words)	Yes[a]
		Recall of objects & recognition tests	No group differences	No
Christensen et al. (in press)	Pregnant women rated that memory had been better 6 months earlier, relative to controls Pregnant women reported memory deterioration relative to pre-pregnancy on a separate question	Word-stem completion, recall & recognition tests	No group differences between pregnants and controls	No

Note. The term 'controls' refer to non-pregnant women. Multi = Multiparous women. [a] Significant correlation reported indicated that poor word-stem priming was associated with perceived memory decline in pregnant women.

1.2 Possible Mechanisms underlying Memory Deficits in Pregnancy

In this section, I briefly review mechanisms that may underlie the postulated objective memory deficits in pregnancy. Both psychological and hormonal factors may influence memory performance during pregnancy. Possible psychological bases for memory deficits are described first. Three of these were chosen for further investigation: inefficient self-initiated retrieval processes, inefficient working memory, and a selective memory bias for pregnancy-related material. The potential role of hormonal factors in the genesis of memory deficits is then reviewed. The possible contribution of depression, anxiety, and sleep loss is also noted.

1.2.1 Psychological Processes in Memory Deficits

A number of different psychological processes have been proposed as the origin of memory deficits during pregnancy. Five possibilities are discussed below. The first three propose that deficits are based on changes in attention during pregnancy, including a general reduction in attention, a temporary lapse in attention, and a selective bias for pregnancy-related information. Two other possibilities are proposed here: inefficiency in self-initiated retrieval processes, and inefficiency in working memory. It is also possible that there are multiple origins of memory deficits in pregnancy, with several of these processes contributing to such deficits.

General reduction in attention. In the first of the attention-based mechanisms, Brindle et al. (1991) suggested that memory deficits are caused by a general reduction in attention to external events during pregnancy. This might be a

consequence of internally focussing and preoccupation with pregnancy (e.g., Bailey & Hailey, 1986; Deutsch, Ruble, Fleming, Brooks-Gunn & Stangor, 1988; Leifer; 1977). If a general reduction in attention occurs, there should be deterioration in cognitive tasks that require attention, such as recall tests. Although findings by Sharp et al. (1993) of deficits on explicit memory tasks are somewhat consistent with this notion, findings from Brindle et al. (1991) and Christensen et al. (in press) are not. These studies found no impairments on recall. Overall, there is weak support for a generalised deficit in cognitive performance as proposed by a general reduction in attention.

Temporary lapses in attention. The possibility that pregnancy might be associated with temporary lapses in attention was offered as an explanation of Brindle et al.'s (1991) inconsistent findings. The findings of impairment on an implicit memory test in which material was incidentally learned, but none on explicit memory tests in which material was intentionally learned, were used to suggest that pregnant women could have temporary lapses in attention that could be reversed with effort.

From this model, Sharp et al. (1993) predicted that memory performance should be impaired following incidental learning where no effort is expended, but unaffected following intentional learning where the use of effort was thought to overcome any deficit. Consistent with this prediction, Sharp et al. (1993) found that, among primiparous women, performance was impaired on a recall test of incidentally learned material, but not on a recall test of intentionally learned material. However,

this result did not extend to multiparous women or tests of recognition. Moreover, the results of Christensen et al. (in press) failed to replicate the finding, reporting that there were no pregnancy-related deficits on recall tests, irrespective of whether the learning conditions were incidental or intentional.

In sum, there is equivocal evidence for the notion of a temporary attentional lapse in pregnancy, which was offered as a post-hoc explanation for a deficit on an implicit memory test. No other studies have consistently confirmed this.

Selective bias for pregnancy-related information. Another possible factor that may affect memory functioning during pregnancy is some form of selective bias for pregnancy-related information and activities (Christensen et al., in press). Here, deficits are a function of the type of material, and are thus content specific. Christensen et al.'s (in press) study suggested that the selective bias might be manifested as a selective attentional shift towards pregnancy-related material or selective recall for pregnancy-related material.

This selective bias model was based on the well-established findings of attention biases in anxiety and memory biases in depressive disorders (for review, see Dalgleish & Watts, 1990). Highly anxious people are known to selectively attend to personally relevant environmental stimuli related to danger and threat. In support of this bias, there is evidence that anxious subjects show impaired colour-naming of threat-related words compared to controls on a Stroop test (Mathews & MacLeod, 1985, 1986). They have also been shown to shift their attention towards threat-related

words in a dot probe attention test, whereas controls shift their attention away from such words (MacLeod, Mathews, & Tata, 1986). Depressed individuals have been shown to have superior memory for negative or depressive material compared to controls (e.g., Denny & Hunt, 1992; Hertel & Hardin, 1990; for review, see Blaney, 1986). In addition, depressed individuals often show impaired memory for positive or neutral information.

Given the possibility that content specificity could affect either attention or memory, Christensen et al. (in press) investigated both of these aspects in pregnant women. The results failed to reveal a content specific effect on a dot probe attention task. That is, pregnant women and controls did not differ in their reaction time to a dot following the presentation of pregnancy-related words or neutral words.

The investigation of memory performance revealed mixed evidence of a content specific effect. Compared to controls, pregnant women showed superior memory for pregnancy-related material on an unsignalled recognition test of incidentally learnt material. However, one drawback of this finding was that false alarms were not assessed, allowing for the possibility that the findings may have been affected by differences in this rate. Also, consistent with a content specific effect, in the baseline condition of a word recall task, pregnant women completed potentially pregnancy-related stems with pregnancy-related words more often than the controls did. However, a content specific effect was not found on two word recall tests in which the recall of pregnancy-related and neutral words were cued with stems. Here, no group differences were found irrespective of the material's content.

In sum, there is tentative evidence for a content specificity effect, which reflects a memory bias for pregnancy-related material. Given the possibility that the effect observed on the recognition test may have been due to differences in false alarm rates, this result requires replication.

Inefficient self-initiated retrieval. A fourth possible origin of memory deficits in pregnancy might be inefficient self-initiated retrieval. Self-initiated retrieval processes (SIRP) relate to the internal generation of cues that are used to aid remembering in the absence of external cues or environmental support. The possibility that the efficiency of these processes declines in pregnancy has been suggested by findings of greater pregnancy-related deficits on recall tests compared to recognition tests (Sharp et al., 1993). This discrepancy has been interpreted as a disruption of SIRP when observed in other groups such as the elderly (Craik, 1986; Craik & McDowd, 1987; Mäntylä, 1994; Maylor, 1993). Craik (1986) argues that because recall tests offer fewer external cues to aid remembering than do recognition tests, successful recall requires the 'rememberer' to generate more internal cues, and hence use more SIRP to do this. As such, a disruption of SIRP would impair recall performance to a greater extent. Although it has been argued that these differences in recall and recognition are simply due to differences in difficulty level, with recall being the more difficult task, Craik and McDowd (1987) have shown that type of task (recall versus recognition), rather than difficulty level, determines deficits.

Not all of the pregnancy evidence to date is consistent with the presence of inefficient self-initiated retrieval. Two studies have failed to reveal pregnancy-related deficits on recall tests (Brindle et al., 1991; Christensen et al., in press). It is possible that deficits were not found in the former study because the requirement for SIRP had been lowered by the use of semantically organised material.

Given that all memory tasks can vary in their requirement for SIRP, it is possible that previous pregnancy studies have failed to reveal deficits because the requirement for SIRP was lower than optimal. Indeed, one view adopted by Craik (1986) is that, of all the different types of memory tasks, prospective memory should show the greatest deficits because it relies more heavily on these processes (see also Maylor, 1993). This is because in prospective memory tests, there are fewer, if any, experimenter cues to initiate remembering. Unlike other forms of memory, prospective memory requires the 'rememberer' to remember that something has to be done.

Following this reasoning, it is possible that a pregnancy-related deficit may be more pronounced on tasks with high demands on SIRP, such as prospective memory, than on tasks with lower demands on SIRP, such as standard recall and recognition tests. In support of this notion, findings from aging studies indicate that cognitive performance is more impaired on tasks with higher requirements for SIRP, than on task with lower requirements (Craik, 1986; Mäntylä, 1994; Maylor, 1993). There is little evidence on whether these processes are disrupted in pregnancy. The results of Casey et al. (1998) for pregnant women and new mothers are not consistent

with inefficient self-initiated retrieval in that no deficits were found on prospective memory. However, it is possible that the requirement for SIRP in the prospective memory task was minimised by the use of external cues such as personal memory aids and reminder cards. Furthermore, as noted earlier, this result cannot inform about pregnant women because the group combined pregnant women and new mothers. No studies have directly investigated the possible disruption of SIRP in pregnancy.

Inefficient working memory. A fifth possibility is that a decline in the efficiency of working memory may contribute to memory deficits in pregnancy. Consistent with this suggestion, some subjective evidence indicates that pregnant women have problems on tasks that require working memory skills, such as reading and problem-solving. As noted earlier, a recent re-analysis of data from Janes et al. (1998) found that pregnant women had impaired backward digit span compared to controls (P. Casey, personal communication, October 22, 1998). However, the pregnant women from Casey et al.'s (1998) study failed to show such deficits.

There is clear evidence from other research that working memory deficits are linked to alterations in psychological and physiological factors, such as mood (for reviews, see Eysenck, 1992; Williams, et al., 1988), and aging (e.g., Baddeley, Logie, Bressi, Della Sala, & Spinnler, 1986; Salthouse, 1990). Given that pregnancy is associated with many alterations in psychological and physiological factors, it is at least plausible that such alterations would have some effect on the working memory of pregnant women.

Summary of possible psychological factors in memory deficits

What can be said about the role of each of these five factors in pregnancy-related cognitive deficits? Clearly, there is insufficient experimental data to evaluate the merit of each conclusively. However, the current evidence suggests that there is, at best, weak support for a general reduction in attention or a temporary attentional lapse. Although data from other fields, such as anxiety, depression, and aging, give plausibility to the notions of content specificity, SIRP, and inefficient working memory, there have been few, if any, direct investigations of such mechanisms in pregnancy. The present thesis will investigate these last three possible origins for the postulated memory deficits in pregnant women.

It should also be noted that this study does not attempt to address possible underlying causes for these psychological changes. One possibility is that the hormonal fluctuations occurring during pregnancy are responsible for the psychological changes that impair cognitive performance. While it is beyond the scope of this sthesis to explore possible hormonal factors in objective memory deficits, a discussion of these issues is covered in the next section.

1.2.2 Hormonal Factors in Memory Deficits

There are extensive hormonal fluctuations during pregnancy that could potentially influence memory performance. Although there is no evidence linking hormones such as estrogen and progesterone directly to memory changes in pregnancy, evidence from other fields gives this notion plausibility. There is

promising evidence from studies of hormone replacement therapy in postmenopausal women that estrogen treatment *enhances* cognitive functions, such as verbal memory (for review, see Sherwin, 1994). It may even offer a protective effect for dementia (Haskell, Richardson, & Horwitz, 1997; Yaffe, Sawaya, Lieberburg & Grady, 1998). On the other hand, estrogen treatment may impair other functions, such as spatial memory.

There is also some evidence from studies of the menstrual cycle linking fluctuations in estrogen and progesterone to changes in memory functioning, although, overall, the evidence for this is inconclusive (e.g., Broverman et al., 1981; Logue & Moos, 1988; for reviews, see Sherwin, 1994, Sommer, 1982). Strikingly, both hormone-replacement and menstrual studies suggest that increases in estrogen are beneficial to some aspects of memory performance. Paradoxically, these findings would suggest that the higher levels of estrogen found in pregnant women should improve at least some areas of memory performance. However, given the suggestion of cognitive deficits in pregnant women, it seems plausible that an 'oversupply' of estrogen as found in pregnant women (as opposed to 'replenished' levels of estrogen in elderly women), could have a negative influence on performance. There are no studies on the effects of estrogen and progesterone changes on memory performance in pregnant women.

With respect to other hormones, a study by Silber et al. (1990) reported higher levels of oxytocin among pregnant women relative to controls, but failed to find an association between oxytocin levels and memory deficits, despite other

research suggesting such a link (Kennett, Devlin, & Ferrier, 1982). Although β-endorphin, plasma cortisol, and corticotrophin releasing hormone all rise during pregnancy (Smith et al., 1990; Smith & Thomson, 1991), their effects on memory functioning in pregnancy have not been investigated.

Another position worth considering is the interaction of hormonal and psychological factors in the precipitation of memory deficits in pregnancy. For example, the effect of hormonal changes may be an indirect one, which operates via an effect on mood or processes of attention. Ballou (1978) suggests that changes in mood resulting from hormonal changes may be responsible for internal focussing or preoccupation with pregnancy and childbirth. Such internal focussing and preoccupation may be one of the bases for memory deficits in pregnancy (see Brindle et al., 1991; Christensen et al., in press).

1.2.3 Depression, Anxiety, and Sleep Loss

In addition to the specific psychological and hormonal explanations for cognitive deficits considered above, it is possible that pregnancy-related changes in mood and sleep loss may contribute to cognitive deficits. As noted earlier, these relationships have not been adequately investigated in pregnant women. Thus, the present thesis will consider the potential effects of mood and sleep loss on the cognitive performance of pregnant women.

1.3 Aims of the Present Study

This thesis aims to investigate the relationship between self-perceptions of memory and objective memory performance in pregnancy. As briefly summarised in Figure 1, it aims to examine a number of possible bases for subjective and objective memory deficits in pregnant women. Thus, the aims of this study are:

(a) To examine the nature of subjective memory functioning in pregnancy:

- (i) To examine whether pregnancy is associated with a subjective memory deficit;
- (ii) To examine whether this deficit is confirmed by informants;
- (iii) To examine whether this subjective deficit is associated with depression, anxiety, or sleep loss.

(b) To examine possible origins of objective memory deficits in pregnancy:

- (i) To investigate whether pregnancy is associated with inefficient self-initiated retrieval as reflected in poorer performance on a prospective memory task;
- (ii) To investigate whether pregnancy is associated with an inefficient working memory;
- (iii) To investigate whether pregnancy is associated with a content specificity effect reflecting a memory bias towards pregnancy-related material;

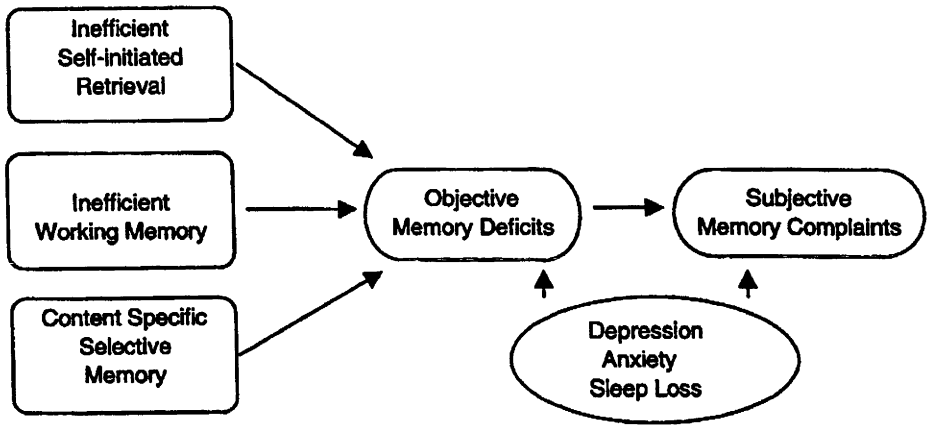

Figure 1. Possible origins of objective and subjective memory deficits in pregnant women chosen for investigation.

(iv) To examine whether performance on objective tests of prospective memory, working memory, and recognition is associated with depression, anxiety, or sleep loss in pregnancy.

(c) To examine the correspondence between subjective memory functioning and objective memory performance in pregnancy:

(i) To examine whether *general* self-perceptions of memory functioning are related to performance on individual tests of prospective memory, working memory, and recognition;

(ii) To examine whether *specific* self-perceptions of prospective memory, working memory, and retrospective memory correspond to performance on objective tests in these domains.

Chapter 2

General Description of Study

All participants completed all parts of the study. This chapter describes the sample, non-memory measures, and the general procedure. Specific details of the memory experiments are described in the following chapters. Ethics approval was obtained from the Australian National University, and the two hospitals involved in the study.

2.0 Participants

A total of 60 women participated in the study: 30 pregnant women, and 30 non-pregnant women. Pregnant participants were recruited through antenatal classes at the John James Memorial Hospital, and Calvary Hospital, Canberra, Australia. Given that the effects of trimester and parity on cognitive performance have not been established, the recruitment was restricted to primiparous women in third trimester (*M*= 33.6 weeks pregnant, *SD*= 2.3, *Range*=28-38).

The non-pregnant women who acted as controls (called 'controls' herein) were recruited through the pregnant participants. Each pregnant participant invited a non-pregnant, childless, female friend or relative of similar age, lifestyle, and background, to be a part of the control group. This was done to ensure that controls

had similar background characteristics to the pregnant women. Where a pregnant woman was unable to identify a suitable non-pregnant woman, candidates that were nominated by other participants were approached.

All participants were volunteers, and were not paid for their participation. They were all at least 18 years old, and had no history of head injury, alcohol abuse, or schizophrenia.

Background information was obtained by asking participants a number of questions concerning age, level of education, marital status, native language, and working status. Furthermore, all participants completed the National Adult Reading Test (Nelson, 1982) for an indication of verbal ability. The NART requires participants to read aloud a list of 52 irregular words, which cannot be pronounced phonetically. NART error scores reflect the number of words pronounced incorrectly out of a possible 52.

Almost all of the participants (95%) were Australian or from another English-speaking country (pregnant: 93%; controls: 97%), and 85% were working full-time at the time of the interview (pregnant: 77%; controls: 93%). Most of the participants (80% in each group) were in professional or managerial occupations. The remaining 20% in each group were in clerical or skilled occupations. All of the pregnant women were married or in a de-facto relationship, whereas 13 of the controls were married, 15 were single, and 2 were divorced. As shown in Table 2, the pregnant women and

controls did not differ in age, years of education, or the National Adult Reading Test (Nelson, 1982).

Table 2
Characteristics of Pregnant Women and Non-Pregnant Controls

Variable	Pregnant (n=30)			Controls (n=30)			$t(58)$[a]
	M	*SD*	*Range*	*M*	*SD*	*Range*	
Age (years)	29.3	3.8	22-37	28.1	3.4	21-35	1.32
Education (years)	13.9	1.8	12-18	14.8	1.9	12-18	1.82
NART error score[b]	17.5	6.6	7-30	17.2	7.4	6-33	0.18
STAI – State	34.3	5.9	25-46	36.0	8.1	24-56	0.93
BDI							
Non-somatic	4.2	3.3	0-13	2.8	2.4	0-9	1.77
Somatic	5.4	2.4	2-10	1.7	1.4	0-5	7.14**
Total	9.5	4.4	2-17	4.5	3.2	0-14	5.05**
Sleep loss	1.4	0.7	0-2	0.7	0.7	0-2	2.49**

Note. NART = National Adult Reading Test. STAI= State Trait Anxiety Inventory.
BDI = Beck Depression Inventory. Higher scores on STAI, BDI, and Sleep loss indicate more symptoms.
[a] Mann-Whitney *U* calculated for sleep loss data. [b] Mean intelligence equivalents for both pregnant women & controls were 113.
*$p < .05$. **$p < .01$.

Informant reports. In addition to collecting data from participants, 43 informants of the women completed questionnaires about the women's memory. Women were asked to invite their husbands to act as informants. Where a husband was not available, women were asked to invite a close relative or friend who had known them for at least two years to act as an informant. There were 26 informants for pregnant women, all of whom were husbands or partners. There were 17

informants for controls, 8 of these were husbands or partners, and the remaining 9 were either close relatives or friends.

2.1 Psychological Measures

Depression. The Beck Depression Inventory (Beck, 1972) was used. It is a well-established scale for detecting depressive symptoms. The BDI was divided into two sub-scales to separate out cognitive-affective symptoms and somatic symptoms as used in other pregnancy studies (see Christensen et al., in press; O'Hara, et al., 1990). The cognitive-affective scale (referred to as non-somatic depression herein) provides a more sensitive indicator of genuine depressive symptoms in pregnancy than does the total BDI scale since pregnancy itself is associated with many of the same somatic changes found in depression (e.g., changes in appetite, sleeplessness, and fatigue). A higher score on the BDI scales represents a higher level of symptoms over the past week.

Anxiety. State anxiety was measured by the state version of Speilberger State Trait Anxiety Inventory (STAI) (Speilberger, Gorush, & Lushene, 1968). This self-completed questionnaire consists of 21 statements about current feelings of anxiety (e.g., "I feel calm", "I am tense"). Ratings are made on a 4 point scale ('Not at all' to 'Very Much So'). Positively phrased items are reversed for scoring, so that a higher score represents a higher level of anxiety symptoms.

Sleep Loss. Sleep loss was measured by two questions about sleeping problems over the past month ("Have you been sleeping poorly?" & "Have you had difficulty falling asleep?"). Responses were either 'yes' or 'no'. Total scores ranged from 0 to 2, with higher scores representing greater sleep loss. These items were taken from a short-form anxiety and depression scale (Goldberg, Bridges, Duncan-Jones, and Grayson, 1988). Research with pregnant women indicates that they report these types of sleep problems (Smith et al., 1990). The two items showed satisfactory internal consistency (Cronbach's α=.51).

2.2 General Procedure

Participants attended one interview lasting approximately 1.5 hours. The interviews were conducted on a one-to-one basis in a room at the University. During the interview, the participant was seated at a desk facing a computer, which was used to display the experimental tasks. Before the commencement of the interview, written consent was obtained from each participant. The participants were aware that the study concerned possible memory impairments during pregnancy. They were informed that the evidence was unclear with respect to changes in memory during pregnancy.

All participants completed three experimental tasks on memory performance. The prospective memory task was administered first, and was followed by a recognition test of words seen in this task, and then by a set of four working memory

tests. These objective tasks were interspersed with a number of self-completed questionnaires about memory functioning and mood. At the end of the interview, participants were invited to complete a memory diary for the following week. Furthermore, all participants were asked to invite an informant to complete the informant's version of the memory functioning questionnaire.

2.3 Group Differences in Depression, Anxiety, and Sleep Loss

As shown in Table 2, the pregnant women were no more anxious or depressed on the non-somatic BDI scale than the controls. As expected, pregnant women reported more somatic symptoms on the BDI. These symptoms were assumed to reflect symptoms of pregnancy rather than depression. Pregnant women reported greater sleep loss than did the controls (see Table 2). These findings confirm the findings of other pregnancy studies (e.g., Christensen et al., in press; Condon et al., 1991).

2.4 Statistical Analysis

Unless otherwise stated, repeated measures ANOVA (MANOVA, SPSS) was used with pregnancy status (pregnant, non-pregnant) as the independent variable, and the various measures of subjective and objective memory as the dependent variables. Independent group analysis was used because the groups were not fully dependent in that it was not possible to match all participants with a self-selected control.

Chapter 3

Perceptions of Memory in Pregnancy

3.0 Introduction

The main aim of this chapter was to examine whether pregnancy is associated with the perception of a memory deficit, and, in particular, to establish whether this occurred in the two areas of memory where objective investigation was planned: prospective memory and working memory. The other aims were to examine whether this deficit was confirmed by informants, and whether it was associated with non-somatic depression, anxiety, or sleep loss.

Unlike most other studies of subjective memory during pregnancy, a comprehensive questionnaire on specific aspects of memory was used. Women rated (a) how often they had a variety of memory problems in the last few weeks, and (b) how often they had such problems normally. Based on past studies (e.g., Brindle et al., 1991; Christensen et al., in press; Sharp et al., 1993), it was expected that pregnant women would perceive that their memory had deteriorated from normal circumstances, whereas controls would report no change in memory functioning. For another indicator of perceived memory change, a separate item asked women to rate how often they used memory aids during pregnancy versus normally (Morris, 1984).

Other research has noted that women report using more memory aids during pregnancy than they normally do (Parsons & Redman, 1991). This perceived change in the use of memory aids would be consistent with their perceptions of memory deterioration.

For the validation of the women's reports, informants also completed the memory perception questionnaire. In addition, women's questionnaire responses were compared to their reports of memory failures collected from diary records. A memory diary can offer a useful validation of questionnaires as they are less likely to be influenced by reporting biases associated with estimating memory problems (Morris, 1984). Notably, questionnaires are more likely to be biased by individual's beliefs or judgements about their memory abilities. The finding of good agreement between questionnaires and memory diaries would indicate that the questionnaires had not been unduly influenced by such reporting biases. Furthermore, a memory diary may also reveal memory problems that may not be captured by a structured questionnaire.

3.1 Methods

3.1.1 Participants

All participants and informants described in Chapter 2 completed the memory perception questionnaires. The subset of participants with diary records is described in the results.

3.1.2 Materials

Memory Perception Questionnaire

A memory perception questionnaire was constructed. The items were drawn from several memory perception questionnaires, largely used in aging studies, to reflect the different areas of memory being investigated. The questionnaire had two sections, each consisting of 14 items about memory functioning (see Appendix A). One section referred to problems occurring in the last few weeks, and the other to those occurring in normal circumstances, but apart from this, the actual items in each section were identical and assessed the following five areas:

General memory. This was measured by one item adapted from Gilewski, Zelinski, and Schaie (1990): "How would you rate your memory (over the last few weeks/under normal circumstances) in terms of the kinds of problems that you have had?". This was assessed on a 7-point response scale (1 = 'major problems', 4= 'some problems' and 7 = 'no problems'). A higher score indicated fewer problems with memory. This item is comparable to that used in other recent studies (e.g., Brindle et al., 1991; Christensen et al., in press; Sharp et al., 1993).

Retrospective memory. This was measured by five items from the Gilewski et al. (1990) memory functioning questionnaire, including forgetting of phone numbers just looked up, phone numbers that are used frequently, names, information, and 'where something is'. All of these items were assessed on a 7-point response scale for frequency of forgetting, where 1 = 'always', 4 = 'sometimes', and, 7 = 'never'. A higher score indicated fewer problems with retrospective memory. The entire

questionnaire has been shown to correlate with measures of retrospective memory performance such as recognition and recall (Zelinski, Gilewski, & Anthony-Bergstone, 1990).

Prospective memory. This was measured by three items chosen to assess the kinds of everyday activities that involve prospective memory (forgetting appointments, birthdays or important dates, and 'to do things, like lock the door'). These items were assessed on a 7-point response scale for frequency of forgetting, where 1 = 'always', 4 = 'sometimes', and, 7 = 'never'. A higher score indicated fewer problems with prospective memory. These items were adapted from Gilewski et al. (1990) and Bennett-Levy and Powell (1980).

Working memory. This was measured by three items chosen to assess the kinds of everyday activities that involve working memory that participants could relate to ('learning new things', 'problem-solving', and 'doing several things at once'). These items were assessed on a 7-point response scale for frequency of problems, where 1 = 'always', 4 = 'sometimes', and, 7 = 'never'. A higher score indicated fewer problems with working memory. The first item was adapted from Bennett-Levy and Powell (1980), and other two were purpose-built as no appropriate items were found in the standard memory questionnaires reviewed.

Use of memory aids. This item was also adapted from Gilewski et al. (1990), and asked about the frequency of using memory aids, such as an appointment book (1 = 'always' to 7 = 'never').

Informant version of Memory Perception Questionnaire

An informant version of the memory perception questionnaire was constructed. This questionnaire was identical to the self-report questionnaire described above except that references to 'you' were replaced with 'your partner/friend' or 'she' as appropriate.

Memory Diary

A semi-structured memory diary was adapted from Reason's diary for recording absentminded acts (Reason, 1984). For each memory problem or failure, participants were required to make an entry into a pocket diary. The entry contained information on three aspects of the memory problem: its nature (e.g., the participant's intentions and actions), its consequences or effect, and the circumstances in which the problem occurred. This information was used to identify the type of memory problem that had occurred. A sample diary and examples of entries are shown in Appendix B.

3.1.3 Procedure

Half of the participants in each group completed the 'last few weeks' section of the memory perception questionnaire first (called *current* herein), whereas the other half completed the 'under normal circumstances' section first. In addition, the two sections of the questionnaire were separated by a five-minute interval filled with other tasks. These steps were taken to reduce the possibility of a response bias associated with completing one section immediately after the other. Informants

completed the memory perception questionnaire in their own time and returned it by reply-paid mail.

For the diary study, participants were instructed to record all memory-related problems in the diary for a period of 7 days, commencing at the end of the interview. They were asked to record details as soon as possible after the memory failure occurred. Given that this would not always be possible, participants were also asked to review each day's events once a day. They returned diaries by reply-paid mail.

3.1.4 Design

The design of the experiment was a 2x2 mixed factorial. For each of the outcomes, the between-subjects factor was pregnancy status (pregnant or non-pregnant) and the within-subjects factor was whether or not the memory perception questionnaire referred to current or normal circumstances (current or normal). Interaction effects were examined using post-hoc t-tests. The same analysis was used for informant reports.

3.2 Results and Discussion

Group differences in self-ratings of memory functioning

Scores for the scales of retrospective memory, prospective memory, and working memory were calculated by adding the respective items together. It is noted that the items in each scale showed good internal consistency, with Cronbach's α ranging from .59 (prospective memory *normal* scale) to .86 (retrospective memory *current* scale). When there was an item missing on any scale (and up to 2 on the

retrospective memory scale), the score was calculated on the basis of the remaining items. If more items were missing, the case was excluded.

Table 3 shows the mean scores and standard deviations for pregnant women and controls for the five areas that were assessed: general memory, retrospective memory, prospective memory, working memory, and use of memory aids.

General memory. Approximately 63% of pregnant women indicated that their memory had deteriorated over the last few weeks, whereas only 13% of controls indicated that their memory had deteriorated. An ANOVA on the mean general memory score revealed a main effect for circumstances ($F(1,58)=9.27$, $MSE=0.61$, $p<.01$). However, this was modified by an interaction between pregnancy status and circumstances ($F(1,58)=26.56$, $MSE=0.61$, $p<.01$), which reflected a perceived deterioration with respect to normal for pregnant women ($t(29)=4.86, p<.01$), but no significant change from normal for controls ($t(29)=1.96, p>.05$). This interaction is illustrated in Figure 2. A similar pattern was found for the specific memory scales discussed below.

Retrospective memory. Among the pregnant women, 83% perceived that they were having more problems with retrospective memory in the last few weeks than they normally had, whereas only 27% of controls also did. An ANOVA on the mean retrospective memory score revealed a main effect for circumstances ($F(1,58)=18.71$, $MSE=0.39$, $p<.01$), and an interaction between pregnancy status and circumstances ($F(1,58)=32.15$, $MSE=0.39$, $p<.01$). This reflected a perceived deterioration with

respect to normal for pregnant women ($t(29)=5.68$, $p<.01$), but no change from normal for controls ($t(29)=1.42$, $p>0.1$).

Table 3

Mean Scores for Memory Perceptions by Participants and Informants

	Memory Perceptions									
	General Memory		Retrospective Memory		Prospective Memory		Working Memory		Use of Memory Aids	
Group/ Circumstances	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
					Participants[a]					
Pregnant										
Current	4.53	0.94	4.57	1.26	5.16	1.42	4.44	1.33	2.43	1.45
Normal	5.70	1.02	5.71	0.64	6.16	0.73	5.92	0.58	3.87	2.11
Controls										
Current	5.10	1.18	5.11	0.97	5.97	0.75	5.49	0.85	2.53	1.70
Normal	4.80	1.45	4.95	1.08	6.02	0.72	5.46	0.82	2.73	1.66
					Informants[b]					
Pregnant										
Current	5.28	1.10	5.48	1.08	5.88	1.32	5.45	1.35	3.54	2.18
Normal	6.36	0.81	6.10	0.82	6.47	0.78	6.26	0.85	3.81	2.23
Controls										
Current	5.92	1.08	5.66	1.41	6.00	0.94	5.73	1.03	3.00	2.22
Normal	6.08	0.90	5.77	1.34	6.13	1.07	5.69	1.13	3.06	2.32

Note. Higher scores indicate better memory functioning (except for memory aids where higher score indicates use of fewer memory aids). Range of scores was 1 to 7. [a] All scales: $n=30$ each for pregnant & controls. [b] Informant numbers varied according to scale. General Memory: $n=25$ for pregnant; $n=11$ for controls. Retrospective Memory: $n=26$ for pregnant; $n=17$ for controls. Prospective & Working Memory, & Memory Aids: $n=26$ for pregnant; $n=16$ for controls.

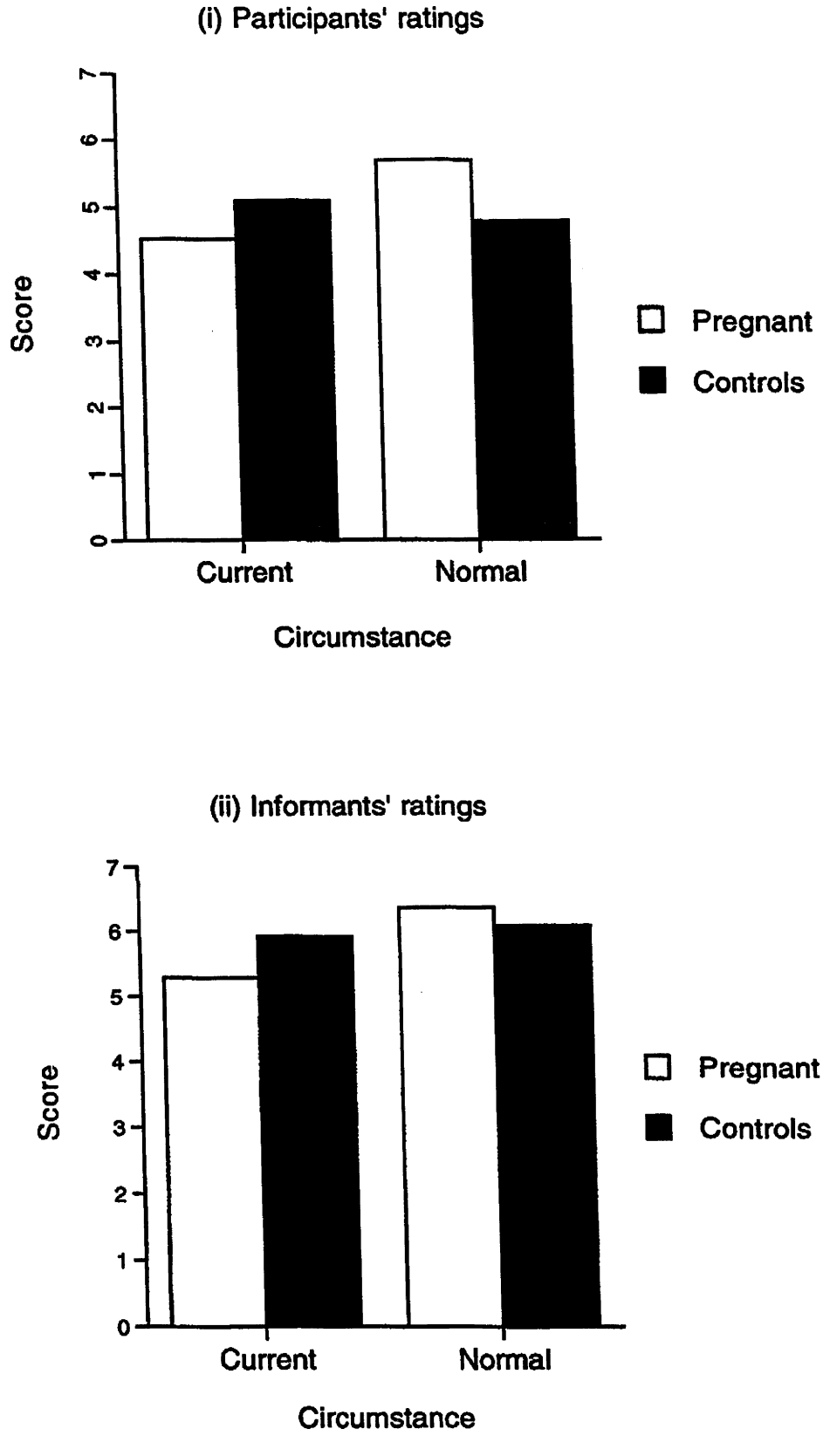

Figure 2. Ratings of 'general memory' as a function of pregnancy status and circumstances for (i) participants, and (ii) informants. Higher scores indicate better memory functioning.

Prospective memory. According to the prospective memory scale, 73% of pregnant women and 40% of controls perceived deterioration in their prospective memory from normal levels. The ANOVA for mean prospective memory scores revealed a main effect for circumstances ($F(1,58)=17.24$, $MSE=0.48$, $p<.01$) and pregnancy status by circumstances interaction ($F(1, 58)=13.80$, $MSE=0.48$, $p<.01$). The interaction effect reflected a perceived deterioration in prospective memory from normal for pregnant women ($t(29)=4.33$, $p<.01$), but no change from normal for controls ($t(29)<1$).

Working memory. Deterioration in working memory from normal levels was reported by 87% pregnant women, but only by 33% of controls. An ANOVA on the mean scores revealed a main effect for circumstances ($F(1,58)=30.36$, $MSE=0.52$, $p<.01$) and an interaction between pregnancy status and circumstances ($F(1,58)=33.23$, $MSE=0.52$, $p<.01$). This interaction reflected a perceived deterioration with respect to normal for pregnant women ($t(29)=6.09, p<.01$), but no change for controls ($t(29)<1$).

Use of memory aids. Among pregnant women, 53% reported that their use of memory aids had increased from normal levels, whereas only 27% of controls reported such an increase. An ANOVA on the mean scores revealed a main effect for circumstances ($F(1,58)=14.86$, $MSE=1.35$, $p<.01$) and an interaction for pregnancy status and circumstances ($F(1,58)=8.47, p<.01$). This reflected an increase in the use of memory aids for pregnant women ($t(29)=4.20$, $p<.01$), but no change for controls ($t(29)<1$).

Diary records

Memory problems recorded in the diary included problems related to retrospective memory (e.g., "forgot the name of a street"), prospective memory (e.g., "forgot a friend's birthday"), and working memory (e.g., "lost track of some tasks I had started but not completed"). A small number of entries were excluded from the analysis because insufficient details were provided or the event was related to inattention or concentration (e.g., "Not noticing traffic when driving").

The compliance rate for completing memory diaries was poor. Diaries were completed by approximately half of the participants in each group. This included 15 pregnant women and 13 controls (50% and 43% respectively). Most of the non-compliant participants indicated that they had not been able to find the time or had forgotten about it when contacted by telephone. It should be noted that the pregnant women who completed the diaries did not differ from the main pregnant group on age, education, NART error scores, self-perceptions of memory functioning, depression, anxiety, or sleep loss. However, the controls who completed the diaries were older, had higher NART error scores, and reported fewer problems with retrospective memory (under normal circumstances) than the main control group.

Of the subset of women with diary records, pregnant women reported a mean of 3.27 memory problems over the week (*SD*=2.49; *Range*=1-11, *Mdn*= 3), and the controls reported a mean of 4.08 (*SD*=3.04, *Range*=0-12, *Mdn*= 3). These sub-groups

did not differ on the mean number of reported memory failures ($t(1,26)<1$).[1] This contrasts with findings for these sub-groups on the memory perception questionnaire, which indicated that the pregnant women perceived that they had more memory problems (on the general memory item for current circumstances) than did controls ($t(27)=5.39, p<.05$).

Summary of self-report measures

In five different areas of memory functioning, pregnant women perceived deterioration compared to non-pregnant controls. These findings are consistent with that of many other investigators (Brindle et al., 1991; Christensen et al., in press; Condon & Ball, 1989; Parsons & Redman, 1991; Poser et al., 1986; Sharp et al., 1993). One new finding of this study not reported elsewhere is that pregnant women perceived that deterioration had occurred in areas other than retrospective memory, including prospective memory and working memory. In addition, women's reports of greater use of memory aids during pregnancy compared to normal are also consistent with their perceptions of a memory deficit.

Pregnant women reported more current memory problems than did controls for general memory ($t(58)=2.06$), $p<.05$), prospective memory ($t(58)=2.76$, $p<.01$), and working memory ($t(58)=3.64$, $p<.01$). Interestingly, pregnant women also rated that their normal performance was higher than that of the controls for general memory ($t(58)=2.78, p<.01$), retrospective memory ($t(58)=3.32, p<.01$), and working

[1] An analysis with outliers removed showed the same findings (pregnant: $M=2.71$, $SD=1.33$, *Range*=1-5; controls: $M=3.42$, $SD=1.97$, *Range*=0-7; $t(24)=1.08$; $p>.1$).

memory ($t(58)=3.64, p<.01$). Christensen et al. (in press) has also found that pregnant women over-rated their normal performance.

In contrast, the memory diary results failed to indicate a greater number of memory lapses among pregnant women, and thus did not confirm the women's ratings on the memory perception questionnaire. The discrepancy between the diary records and memory perceptions may have occurred for a number of reasons. It may be a function of the different methods used (behavioural vs. self-rating). As noted earlier, this may be because diary records are less susceptible to reporting biases. However, other studies have found a reliable relationship between self-ratings of memory abilities and diary entries of memory failures (e.g., Shlechter, Herrmann, & Toglia, 1990).

Possibly, the discrepancy may be related to the lack of comparable assessment periods since self-ratings were taken before the diary study. Furthermore, the diaries did not assess change in the frequency of memory problems between pregnancy and normal state. This would require collecting diary records prior to becoming pregnant, which on a practical level would have been difficult to include here. Finally, diaries may have been inaccurate because diarists may underestimate their memory problems. This may occur because respondents with memory problems are more likely to forget that the problem occurred (also called the 'memory introspection paradox', see Herrmann, 1990).

Group differences in informant ratings of memory functioning

For the informant reports, the items comprising the three memory scales also showed very good internal consistency (Cronbach's α=.80 for working and prospective memory scales, to .90 for retrospective memory scales). Table 3 shows the means and standard deviations for the informant reports of general memory function, retrospective memory, prospective memory, working memory, and use of memory aids.

General memory. Informants perceived that 60% (n=15/25) of pregnant women, and 27% (n=3/11) controls had more problems now than they had normally with general memory function. An ANOVA for the mean scores revealed a main effect for circumstances (F(1,34)=9.97, MSE=0.61, p<.01) and an interaction between pregnancy status and circumstances (F(1, 34)=5.05, MSE=0.61, p<.01). This indicated that informants perceived deterioration in memory from normal for the pregnant women (t(24)=44.55, p<.01), but no change in memory for the controls (t(10)<1).

Retrospective memory. Informants perceived that 81% (n=21/26) of pregnant women, but only 35% (n=6/17) of controls had more problems now than they had normally with retrospective memory. An ANOVA on the mean scores revealed a main effect for circumstances (F(1,41)=14.62, MSE=0.19, p<.01) and an interaction between pregnancy status and circumstances (F(1, 41)=7.36, MSE=0.19, p<.01). The interaction effect reflected a perceived deterioration in retrospective memory with respect to normal for pregnant women (t(25)=4.58, p<.01), but no change for controls (t(16)<1).

Prospective memory. Informants perceived that 54% (n=14/26) of pregnant women, and 31% (n=5/16) of controls had more prospective memory problems now than they did normally. An ANOVA on the mean scores revealed a main effect for circumstances ($F(1,40)=7.91$, $MSE=0.32$, $p<.01$), but no interaction effect between pregnancy status and circumstances ($F(1,40)=3.34$, $MSE=0.32$, $p=.07$). Although the main effect indicated that all women were perceived to have poor prospective memory now than under normal circumstances, the trend suggested that pregnant women, not controls, showed deterioration.

Working memory. Informants perceived that 69% (n=18/26) of pregnant women, but only 12% (n=2/16) of controls had more problems with working memory now than they had normally. An ANOVA for mean scores revealed a main effect for circumstances ($F(1,40)=9.36$, $MSE=0.31$, $p<.01$) and an interaction effect between pregnancy status and circumstances ($F(1,40)=11.53$, $MSE=0.31$, $p<.01$). This reflected a perceived deterioration in working memory for pregnant women ($t(25)=4.21$, $p<.01$), but no change for controls ($t(15)<1$).

Use of memory aids. The informants of pregnant women reported that 23% had increased their use of memory aids, but informants of controls reported that only 6% had increased their use of memory aids. The informant reports failed to show any differences between the pregnant women and the controls on their current and normal patterns of use of memory aids, but the trend suggested that pregnant women, but not controls, increased their use of memory aids during pregnancy. However, this effect

was not significant. Notably, the ANOVA revealed no effects for pregnancy status ($F(1,40)<1$), circumstances ($F(1,40)=2.42$, $MSE=0.23$, $p>.1$), or pregnancy status by circumstances ($F(1,40)<1$).

Summary of informant ratings of memory functioning

Informants perceived deterioration to occur in women's general memory, retrospective memory, and working memory during pregnancy. The findings for prospective memory and memory aids, although not statistically significant, also showed a trend in the same direction, suggesting that memory deterioration had occurred. These findings are generally consistent with two other pregnancy studies, which have found that informants report that they had observed memory deterioration in pregnant women (Christensen et al., in press; Condon & Ball, 1989). Despite these indications that women's memory functioning had deteriorated during pregnancy, the informants did not report a higher rate of *current* problems among the pregnant women compared to controls for any area of memory (*ps*>.05). They also indicated that there were no differences between the two groups for their normal performance (*ps*>.05).

Correlations between participants and informants on memory perceptions

Correlations between the women and their informants on their perceptions of memory functioning are shown in Table 4. These relationships were positive for all scales when *current circumstances* were assessed. The association was only significant for retrospective memory and use of memory aids for *normal circumstances*.

Table 4
Correlations between Participants and Informants on Memory Perceptions

Circumstances	General Memory	Retrospective Memory	Prospective Memory	Working Memory	Memory Aids
Current	.31*	.46**	.38*	.43**	.27
Normal	.04	.31*	.07	.21	.41**

Note. Values are Pearson correlation coefficients. *n* values range from 38 to 43 due to missing informant data.
*$p < .05$, **$p < .01$.

Possible correlates of memory complaints in pregnancy

The relationships between self-perceptions of memory functioning and symptoms of non-somatic depression, anxiety, and sleep loss were examined. As shown in Table 5, only non-somatic depression was significantly correlated with any of the memory perception scales. In pregnant women, non-somatic depressive symptoms were related to memory complaints, whereas, in controls, there was no such relationship. The effect found for pregnant women cannot be attributed to greater depressive symptoms since they were no more depressed than the controls. One explanation for the finding is that the presence of depressive symptoms in pregnancy may sensitize women to memory and other problems. On the other hand, both depressive symptoms and memory complaints may reflect a general subjective bias towards reporting symptoms in pregnancy. Alternatively, this finding may reflect that there was a greater range of subjective memory scores among the pregnant women.

Table 5

Correlations between Memory Perceptions and Mood Symptoms

Memory Self-Perceptions[a]	Depression (Non-somatic)	Anxiety (STAI – State)	Sleep Loss[b]
General Memory			
All Participants	-.34**	-.25	-.18
Pregnant	-.44*	-.36	-.27
Controls	-.17	-.26	.06
Retrospective Memory			
All Participants	-.16	-.07	.04
Pregnant	-.18	-.01	.02
Control	.01	-.20	.28
Prospective Memory			
All Participants	-.20	-.13	-.11
Pregnant	-.21	-.20	-.11
Control	.04	-.22	.14
Working Memory			
All Participants	-.62**	-.22	-.09
Pregnant	-.71**	-.34	-.14
Control	-.36	-.30	.29

Note. Values are Pearson's correlation coefficients, unless otherwise stated. Higher value on memory rating indicates better memory functioning. Higher value on Depression, Anxiety, and Sleep Loss indicates more symptoms. [a] N=60 for all participants; n=30 for pregnant and control groups.
[b] Spearman's rank correlation coefficient.
*$p < .05$. **$p < .01$.

Methodological Issues

The memory perception questionnaire clearly showed that pregnant women reported a change in memory functioning in the last few weeks compared to normal circumstances, whereas the controls did not. While these results are consistent with other pregnancy-memory studies, and confirm findings of two studies using a similar questionnaire (e.g., Brindle et al., 1991; Sharp et al., 1993), the methods used to assess memory perceptions might be improved. Although the pregnant women in this study were clearly making a relative judgement about memory change from a pre-pregnancy state (6-8 months earlier), the controls were making a judgement that did not clearly relate to a specific period, and which may have been less sensitive to change. Measurements taken over a specific time period, such as one year, would ensure greater comparability of judgements made by pregnant women and controls. However, ratings made by the two groups should be reasonably comparable since the controls' perceptions of their memory under normal circumstances would be a generalisation of what they perceived their memory to be like over the recent past.

Whereas most other recent pregnancy-memory studies have assessed subjective memory functioning using a single questionnaire item (e.g., Brindle et al., 1991; Christensen et al., in press; Sharp et al., 1993), this study examined a variety of memory domains. Given that items were drawn from several questionnaires and two new items were developed for this purpose, the scales used here have not been subjected to reliability and validity testing. In support of the use of these scales, the items showed high internal consistency (i.e., Cronbach's alpha). Furthermore, other research has shown that memory perception questionnaires containing multiple items

are better predictors of memory performance than single general memory items (Gilewski et al., 1990). In addition, the probing of specific areas of memory as done here should be more sensitive to different patterns of deficits, which could be lost in a general item. Although these domain-specific scales are an improvement on single general items about memory functioning, further questionnaire testing is warranted, particularly to ascertain whether these scales validly reflect the domains they purport to measure.

3.3 Conclusions

In this investigation, women consistently reported deterioration in memory functioning during pregnancy as found in many other studies of memory in pregnancy. In addition to confirming general reports of memory deterioration, this study has extended these findings to include two other areas of memory: prospective memory and working memory. Informants also perceived that the women's memory had deteriorated during pregnancy, suggesting that the effect was genuine. Although the pregnant women rated that their current performance was worse than that of the controls, the informant ratings and the diary data did not suggest that pregnant women were experiencing greater memory problems. Memory complaints in pregnancy were associated with non-somatic depressive symptoms, but not with anxiety or sleep loss. The following two chapters examine the possible objective bases of women's complaint.

Chapter 4

Prospective Memory and Inefficient Self-initiated Retrieval

4.0 Introduction

This chapter aims to examine the first of the three possible origins of memory deficits in pregnancy. That is, whether pregnancy is associated with inefficient self-initiated retrieval as revealed by poor prospective memory performance. If it is the case that pregnant women have inefficient SIRP, then objective problems might be revealed on prospective memory tasks, given that prospective memory may be particularly sensitive to the disruption of SIRP (Craik, 1986). Furthermore, any increase in the need for SIRP should result in greater decrements in the performance of pregnant women relative to controls. To test this prediction, two levels of a prospective memory task were constructed. One provided a relatively low requirement for SIRP, whereas the other provided a relatively high requirement for SIRP. Finally, whether women's reports of memory deterioration as found in Chapter 3 correspond to performance on prospective memory tests was investigated.

The prospective memory task selected was adapted from Mäntylä (1993, 1994). It required participants to remember to perform an action at a future time, in this case to remember to press a given key on the keyboard upon encountering a

target word in a list of words in the context of a word association task. A central component of a prospective memory task is that it should generate forgetting of the to-be-remembered action. This is typically achieved by making the to-be-remembered action a secondary or irrelevant component of the main experimental instruction (see Kvavilashvili, 1992). The word-association task, which required the participants to generate word associations for each word in the list, was used for this purpose.

To create a relatively low and a relatively high requirement for SIRP, item typicality was manipulated. That is, the target words were either typical or atypical instances of a given semantic category (e.g., for the category of fruit: 'apple' is typical, 'fig' is atypical). The reasoning is that remembering to perform an action that is cued by a typical word requires fewer SIRP than one cued by an atypical word because the typical word offers a more effective, external cue to aid remembering of the semantic category. Other research shows that prospective remembering deteriorates as a function of decreasing typicality, and deteriorates more rapidly for elderly groups relative to younger ones (Mäntylä, 1993, 1994).

Successful prospective memory necessarily involves retrospective memory. This is because, in addition to remembering *that* something has to be done, prospective memory involves remembering *what* it is that has to be done. Performance on the prospective memory task can be divided into these two components. Pregnancy-related deficits may arise from a specific difficulty with one or the other component, as found in other research on the elderly (see Dobbs & Rule,

1987; Einstein, Holland, McDaniel, & Guynn, 1992; Mäntylä, 1994). Therefore, to assess both of these aspects of prospective memory performance, two scoring methods were used. One scoring method reflected the prospective memory component of the task only ('remembering to act'). This represented the number of times the participant remembered to perform an action, irrespective of whether the action performed was correct, as a proportion of the total number of targets. The second score reflected both the prospective and the retrospective memory components ('remembering the correct action'), representing the number of times participants remembered to perform the correct action as a proportion of the total number of targets.

4.1 Methods

4.1.1 Participants

All participants described in Chapter 2 completed this experiment.

4.1.2 Materials and Procedure

Two comparable lists of 162 words were constructed. Each list consisted of 12 target words (i.e., six typical-atypical word pairs) that were mixed with 150 non-target words. The target words were generated from four different semantic categories: 'article of furniture', 'type of fruit', 'type of vehicle', and 'a part of a building'. As found in Mäntylä (1994), four different categories were used to increase the difficulty of the task. From each category, a typical and an atypical member were chosen to be targets, according to the category norms of Battig and

Montague (1969). This generated four pairs of typical/atypical targets (e.g., chair-clock, apple-fig). To increase the number of target events, two more pairs were generated from two of the categories (using all four categories across the two lists) so that there were six pairs of typical/atypical target words altogether in the list (see Appendix C for list of target word pairs). The non-target words were chosen from Kucera and Francis (1967), matching word frequency with those of target words (to ensure that target words were not distinctive). This excluded any words from the four semantic categories or any other related word that might be misconstrued as being part of one of the four categories.

The participants were presented with one list of words, which had been randomly ordered for each participant. The words were presented one by one for 3 seconds each on a computer screen, with one word being automatically replaced by the next. Each list was used an equal number of times within each group. Using two comparable lists allowed for generalisation to a wider range of target items.

The participant was instructed to generate aloud a word association for each word in the list as it appeared (e.g. list word = *egg*, generated word = *yolk*), which could be any other word which came to mind. For the prospective memory part of the task, the participant was instructed to also press a response key when an instance of one of the four target categories appeared. A different response code was chosen for each target category, and corresponded to the standard number keys on the keyboard: '1' for furniture, '2' for fruit, '3' for vehicle, and '4' for building. Prior to the test, participants were given approximately 30 seconds to memorise the response code-

category pairings displayed on a show card. They also had a short practice trial in which a sample of target and non-target words not used in the main test were presented. The test duration was 12 minutes.

Participants were advised to guess at the response code if they could not remember which one to use. The interviewer recorded the number of times that the participants failed to generate a word association. This data was used to monitor the participant's attention to the word association task. Throughout the task, any key presses were automatically recorded by computer in milliseconds, providing the associated latency from the onset of the word triggering the response.

4.1.3 Design

The design of the experiment was a 2x2 mixed factorial, in which pregnancy status of participants (pregnant or non-pregnant) was the between-subjects variable and the measures of prospective memory were the dependent variables ('remembering to act' and 'remembering the correct action'). The typicality of the target event (typical or atypical) was the within-subjects variable.

4.2 Results and Discussion

Valid responses to target words included only those responses made while the target word was displayed (i.e., 3000 milliseconds). All other responses to non-target words were recorded as false alarm responses. To ensure that participants had followed the task instructions correctly, failures to generate word associations and false alarm responses to non-target words were recorded. Both pregnant women and

controls had a low failure rate (6%) on the word association task (pregnant: M=6.09, SD=4.57; controls: M=6.36, SD=6.91; $t(58)<1$), and a low false alarm rate (<4%) (pregnant: M=2.31, SD=3.77; controls: M=1.80, SD=2.73; $t(58)<1$).

Group differences in prospective memory performance as a function of word typicality

In general, success at remembering to perform an action was approximately 50% (±27%) for the typical condition, and 25% (±19%) for the atypical condition. This suggested that the task was sufficiently difficult, and that the atypical condition was more difficult than the typical condition. The pattern of data is consistent with the notion that the atypical condition required more self-initiated retrieval processes than the typical condition.

The means and standard deviations for 'remembering to act' and 'remembering the correct action' in response to typical and atypical category words are shown in Table 6. The analysis of variance for 'remembering to act' revealed a main effect for typicality of category word ($F(1,58)=85.01$, $MSE=225.49$, $p<.01$), but no effects for pregnancy status or pregnancy status by typicality of category word ($F(1,58)<1$). This indicated that women from both groups were better at identifying typical targets than atypical targets.

Similarly, the analysis for 'remembering the correct action' revealed a main effect for typicality of category word ($F(1,58)=74.11$, $MSE=231.00$, $p<.01$), but no effects for pregnancy status ($F(1,58)=1.30$, $MSE=859.36$, $p>.1$) or pregnancy status by typicality of category word ($F(1, 58)>1$). This analysis indicated that overall

prospective memory performance was better for typical targets than for atypical targets. Furthermore, pregnant women failed to show greater decrements in performance than controls as the typicality decreased.

Table 6
Percentage Correct for Prospective Memory Task as a function of Word Typicality

	'Remembering to act'		'Remembering the correct action'	
Group[a]/ Word Typicality	*M*	*SD*	*M*	*SD*
	Responses within 3000 milliseconds			
Pregnant				
Typical	57	27	53	28
Atypical	29	20	28	19
Controls				
Typical	51	28	46	25
Atypical	27	20	23	20
	Responses within 9000 milliseconds			
Pregnant				
Typical	58	28	53	29
Atypical	33	25	30	22
Controls				
Typical	56	29	47	25
Atypical	29	20	24	20

Note. The values represent the percentage correct. [a] $n = 30$ for each group.

Performance as measured by 'remembering the correct action' (M=74, SD=42) was lower than that measured by 'remembering to act' (M=82, SD=43) ($F(1,58)=22.00$, $MSE=76.71$, $p<.001$), but did not differ between the two groups ($F(1,58)=1.48$, $p>.1$). Although women were worse at remembering the correct

action than they were at remembering to act, there was no difference between pregnant women and controls on these measures.

The above criteria for calculating false alarm responses may have inadvertently included some 'late' responses to target words (i.e., responses occurring shortly after the 3000 millisecond window in which the target was displayed). However, even when late responses were included in the performance measures, no group differences were found. In these analyses, target responses included any responses made between onset of the target word and 9000 milliseconds later (i.e., the next two word trials in which a late responses may have been made). The means and standard deviations for these responses are shown in the lower half of Table 6. For both 'remembering to act' and 'remembering the correct action', the results were identical to the original analyses, showing a main effect for typicality ($F(1, 58)=77.32$, $MSE=264.53$, $p<.01$; $F(1, 58)=65.33$, $MSE=250$, $p<.01$; respectively), but no other effects ($p>.1$).

Correlations between prospective memory performance and possible confounding factors

The relationship between prospective memory performance and possible confounding factors of non-somatic depression on the BDI, anxiety, and sleep loss was assessed (see Table 7). Whether measured by 'remembering to act' or 'remembering to perform the correct action', prospective memory performance was not related to any of these factors. This held for the entire sample, and also separately for the pregnant women and controls.

Table 7
Correlations between Prospective Memory Performance and Other Variables

	Potential Correlates of Performance			Self-Perceptions of Memory	
Prospective Memory Task	Depression (Non-somatic)	Anxiety (State)	Sleep Loss[a]	Prospective Memory	General Memory
All participants (N=60)					
Remember to act	.05	-.16	-.10	.05	-.08
Correct action	.08	-.17	-.04	.03	-.09
Pregnant (n=30)					
Remember to act	-.06	-.03	-.14	-.01	-.17
Correct action	-.03	-.02	-.05	.00	-.18
Controls (n=30)					
Remember to act	-.15	-.24	-.16	.27	.03
Correct action	-.15	-.27	-.19	.25	.06

Note. Values are Pearson's correlation coefficients, unless otherwise stated. All *ps* >.05.
[a] Spearman's rank correlation coefficient.

Correlations between prospective memory performance and memory ratings

There were no significant associations between prospective memory performance and current self-ratings of prospective memory and general memory, as shown in Table 7.

Methodological Issues

The present study investigated what Einstein and McDaniel (1990) have referred to as event-based prospective memory, which is a type of prospective memory where some external cues are provided. Under these conditions, no

pregnancy-related deficit was found, despite a strong typicality effect suggesting there was a high demand on self-initiated retrieval. It is possible that a deficit might still be identified on a time-based task. Time-based tasks require participants to remember to perform an action at a certain time, often without assistance of external cues, and in doing so, places high demands on SIRP (Einstein & McDaniel, 1990; Maylor, 1990, 1993). However, other research tentatively suggests that time-based prospective memory may not be impaired in pregnant women. Casey et al. (1998) revealed that a combined group of pregnant women and new mothers were as successful as controls in remembering to make a telephone call at the end of a week. Furthermore, a subset of pregnant women and controls from the present study did not differ on a time-based prospective memory task.[1]

Summary and Conclusion

This study has extended objective findings about pregnancy and memory to include prospective memory, an area that has not been examined to date. There was no evidence for a deficit in prospective memory that occurred as a function of item typicality. To the extent that this manipulation reflects the use of SIRP, there was no support for the disruption of these processes in pregnancy. This is consistent with two previous findings in which pregnant women were as successful as non-pregnant women on both recall and recognition tests, despite the tests having different requirements for self-initiated retrieval (Brindle et al., 1991; Christensen et al., in press).

[1] The task was adapted from the Rivermead Behavioural Memory Test (see Cockburn & Smith, 1994) and required participants to stop a timer after either 5 or 20 minutes had elapsed. No differences were found between pregnant women (n=24) and controls (n=27) ($\chi^2 = 0.78, p>.1$).

Finally, there was no evidence for an association between women's performance on the prospective memory task and their perceptions of memory functioning, whether measured by general or specific items. Thus, the discrepancy between subjective memory reports and objective memory performance found in other studies for retrospective memory tests was found in the present study for prospective memory. The next chapter examines whether working memory performance is impaired during pregnancy.

Chapter 5

Working Memory and a Selective Memory Bias

5.0 Introduction

Another area of memory that has received little attention in previous pregnancy-memory studies is that of working memory. This chapter aims to investigate two possible origins of memory deficits in pregnancy: (1) inefficient working memory, and (2) a selective memory bias in which memory for non-pregnancy material is impaired. Lastly, this chapter will examine whether pregnant women's perceptions of memory deterioration as reported in Chapter 3 correspond to their performance on objective tests of working memory.

In the present study, working memory performance was measured by a modified version of the reading span test (Daneman & Carpenter, 1980), a test that is widely used for this purpose. In this test, participants read aloud a set of sentences and learn the final word of each sentence for a later memory test. In a typical reading span test, the number of sentences is increased until the participant makes an error in recall. Here, all participants completed all sets of sentences up to four, irrespective of the number of errors made. This measure of working memory performance is sensitive to low and moderate scorers.

Daneman and Carpenter (1980) conceptualised working memory as one system containing a set of processes and resources for complex cognitive tasks such as reading comprehension. Although other researchers have conceptualised working memory somewhat differently, for example, as a three-component system (e.g., Baddeley, 1986), they all agree that the critical aspect of working memory is that it involves the simultaneous storage and processing of information. The reading span task has been designed to meet these requirements for simultaneous storage and processing. In addition, studies have shown that reading span can distinguish poor and good readers, who are argued to differ in their availability of working memory resources (Daneman & Carpenter, 1980, 1983; see also King & Just, 1991; Just & Carpenter, 1992).

In pregnancy, deficits in working memory may be more pronounced as the demand on working memory resources is increased. In fact, deficits may not appear at all if the demand on working memory resources is low. This type of effect has been found in other studies for elderly populations (e.g., Babcock & Salthouse, 1990; Foos, 1989; Foos & Wright, 1992; Gick, Craik, & Morris, 1988). To ensure that the demand for working memory resources was sufficient to reveal any deficit, and to assess whether deficits become more pronounced as the demand on working memory resources is increased, both a relatively simple and a relatively complex version of the reading span task were constructed. The complex task was constructed by increasing the word length of the final words (i.e., number of syllables). Other research has shown that recall performance is lower when word length (or the associated spoken duration) is higher (Baddeley, Thomson, & Buchanan, 1975; see

also Baddeley et al., 1986; La Pointe & Engle, 1990). Furthermore, the complex condition used longer sentences, as this would require more processing resources.

This experiment also investigated whether or not working memory deficits were specific to the type of to-be-remembered material. Thus, two types of material were used: pregnancy-related, and non-pregnancy. As argued in the introduction, there is some evidence for a content-specificity effect in pregnancy. This was suggested by the finding that pregnant women had better memory than did controls for pregnancy-related material. If pregnancy is associated with a content-specific effect, the performance of pregnant women, but not the controls, should vary as a function of the type of material. Although the evidence to date (from recognition memory) suggests that pregnant women may have enhanced memory for pregnancy-related material and intact memory for other material (Christensen et al., in press), other possible patterns of results would also be consistent with a content specific effect. For example, pregnant women may perform equal to, or better than, controls on a test of pregnancy-related material, but worse on a test of non-pregnancy material.

5.1 Methods

5.1.1 Participants

All participants described in Chapter 2 completed the experiment.

5.1.2 Materials

Four conditions of 40 sentences each were constructed, making 160 in total. The 4 conditions were: (1) short sentences (and short final words) with pregnancy content; and (2) long sentences (and long final words) with pregnancy content; (3) short sentences (and short final words) with non-pregnancy content; (4) long sentences (and long final words) with non-pregnancy content.

Short sentences contained approximately 10 words, whereas long sentences contained approximately 16. Pregnancy-related sentences covered themes related to pregnancy and childbirth, whereas the non-pregnancy sentences were about cardiology and related health issues. Issues related to cardiology were expected to be of general interest to all participants and shared some similarities with the pregnancy material in that they contained medical and health themes. The sentences were adapted from several textbooks and manuals about either pregnancy or cardiac heart disease. An example of each type of sentence is given in Table 8. The full list of sentences is shown in Appendix D.

Target words, which were studied for a later memory test, were the final word of each sentence (e.g., 'spine' in the first example sentence of Table 8). These target words were also varied in syllable length for short and long sentences. Short sentences contained a one-syllable target word, whereas the long sentences contained either a two- or three- syllable target word. The target words were matched across conditions on word frequency according to Kucera and Francis (1967). The target

words were unique in that they were not repeated in other sentences or in other experiments.

Table 8

Examples of the four conditions of sentences used in the working memory test.

Type of Sentence/ Length	Example of sentence[a]
Pregnancy-related	
Short	An epidural needle is punctured into the lower spine.
Long	Mothers who participate in early discharge programs receive home visits from midwife services.
Non-Pregnancy	
Short	Coronary bypass surgery is a common and reliable choice.
Long	Complete recovery is not guaranteed for cardiac patients selecting to have a bypass operation.

[a] The underlined word is the target word.

Furthermore, target words of each sentence were chosen so that they were not specifically pregnancy or cardiac-type words (e.g., words such as 'baby' or 'heart' were not used as target words). This was because the word frequency of pregnancy words might be higher in pregnant women (due to their higher exposure to such words).

5.1.3 Procedure

All participants were presented with two trials each of: two sentences, three sentences, and four sentences. Each sentence appeared for 8 seconds on a computer screen. The first trial consisted of two sentences (referred to as set size 2). In this case, a participant was presented with one sentence (e.g., "Some new born babies are marked by red bumps and spots."), followed by a second sentence (e.g., "Pelvic floor exercises can successfully restore muscle tone."). Participants read each sentence aloud at a normal reading pace and were instructed to learn the target words ('spots' and 'tone') in forward serial order for a memory test at the end of the set. To ensure that the participant fully processed the sentences for meaning, and did not just skip to the target word, the participants were informed that they would be required to report on the content of one of the sentences from the set (see Fincher-Kiefer, Post, Greene, & Voss, 1988). Fincher-Kiefer et al. (1988) found that reading span was sensitive to these task demands, showing that reading span was lower when text recall was required. At the end of the set, the participants were asked to recall the target words aloud in the order that they appeared (i.e., spots, tone), and then asked to report on the contents of a randomly selected sentence.

Participants were then given another trial at set size 2. The same procedure was used to present further trials at set size 3 and 4. As found in La Pointe and Engle (1988), these trials were used to calculate the total working memory (WM) score described below. In addition, participants with perfect target recall for all 6 trials were given additional trials at higher set sizes. This included two trials at set size 5, which was followed by two trials at set size 6 for those with perfect recall at set size 5. Set size 6 was chosen as the limit because it was expected that few participants, if

any, would be successful at this level. This additional data was used to calculate reading span similar to that of Daneman and Carpenter (1980).

Each sentence appeared no more than once for each participant. In each condition, sentences were randomly ordered such that any of the 40 sentences could be used in any of the possible 10 trials. These were re-randomised for each participant. Participants completed all four conditions of the working memory test, one at a time, and interspersed with breaks to complete self-report questionnaires. The order of conditions was counterbalanced for individuals.

5.1.4 Scoring

Total WM score. Following LaPointe and Engle (1990), this score represented the total number of final words that were recalled (in forward serial order) in each of 18 trials across set sizes 2 to 4 which had been completed by all participants. The lowest score could potentially be zero (i.e., no words recalled on any of the trials), and the highest score could be 18 (i.e., perfect recall on all trials = 2+2+3+3+4+4). This scoring method is sensitive to low and middle scorers.

Reading span. This represented the highest set size reached without making any errors, plus extra credit (0.5 point) for perfect recall in one of the two trials at the next higher set size. Target word recall was considered correct if the correct words were recalled in the correct order. The lowest score that could be recorded was '1' for cases in which both trials at set size 2 were incorrectly recalled. The highest score was '6', as this was also the highest set size administered. According to this scoring

method, a participant who had perfect recall on both trials at set size 2, but only had perfect recall for one of the two trials at set size 3, would have a strict working memory score of 2.5. This method is sensitive to high scorers.

5.1.5 Design

The design of the experiment was a 2x2x2 factorial. The between-subjects factor was the pregnancy status of participants (pregnant or non-pregnant). The two within-subjects factors related to the sentence length (short or long) and the sentence type (pregnancy-related or non-pregnancy). Interaction effects were examined using post-hoc t-tests.

5.2 Results and Discussion

Group differences on working memory test

Total WM score. The mean percent correct and standard deviations for the total WM score are shown in Table 9. The ANOVA for this score revealed a main effect for sentence length ($F(1,58)=287.87$, $MSE=109.02$, $p<.01$) and sentence type ($F(1,58)=5.73$, $MSE=136.65$, $p<.05$). As shown in Figure 3(i), there was an interaction between sentence length and sentence type ($F(1,58)=6.26$, $MSE=89.51$, $p<.05$), which indicated that, for short sentences, words from pregnancy sentences were recalled better than words from non-pregnancy sentences ($t(59)=3.29, p<.01$). In contrast, performance on long sentences did not differ as a function of sentence type ($t(59)<1$).

Table 9

Working Memory Performance in Pregnant Women and Controls

	Short sentence				Long sentence			
	Pregnancy-Related		Non-Pregnancy		Pregnancy-Related		Non-Pregnancy	
Group[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Total WM score (% correct)				
Pregnant	82	13	72	13	54	13	50	16
Controls	78	16	75	13	55	15	57	13
				Reading span[b]				
Pregnant	3.00	0.64	2.62	0.64	1.83	0.36	1.83	0.51
Controls	2.78	0.74	2.58	0.60	1.78	0.68	1.95	0.46

Note. WM = Working memory. [a]$n = 30$ for each group. [b]Score ranges from 1 to 6.

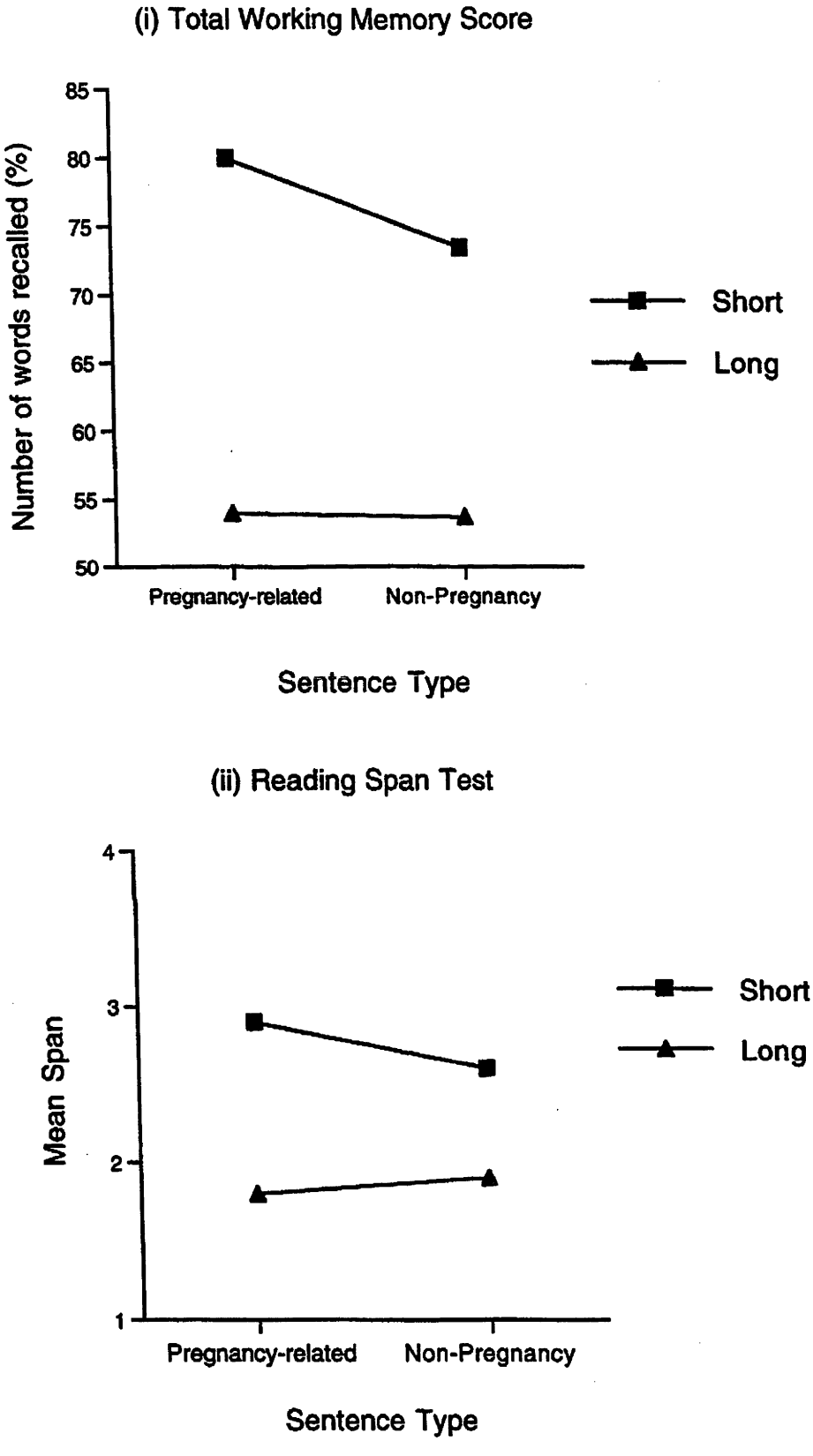

Figure 3. Interaction of sentence length (short/long) and sentence type collapsed over pregnant and controls groups for (i) total working memory score, and (ii) reading span test.

More importantly, there was an interaction effect between pregnancy status and sentence type ($F(1,58)=5.73$, $MSE=136.65$, $p<.05$). This interaction is shown in Figure 4(i) where the data has been collapsed over short and long sentences for the overall comparison of pregnancy-related and non-pregnancy sentences. Post hoc t-tests revealed that there were no differences between pregnant women and controls in their performance on either pregnancy-related sentences ($t(58)<1$) or non-pregnancy sentences ($t(58)=1.76$, $p=.08$). These findings indicate that the significant interaction was the result of the combined effect of pregnant women having marginally higher scores than the controls on the pregnancy-related material, as well as having marginally lower scores than the controls on the non-pregnancy material. Finally, there was no three-way interaction for pregnancy status by sentence length by sentence type ($F(1,58)<1$), indicating that the sentence type bias was equally apparent at both levels of complexity.

Reading span. The means and standard deviations for reading span are shown in Table 9. An ANOVA for this score revealed a main effect for sentence length ($F(1, 58)=190.50$, $MSE=0.25$, $p<.01$). This was modified by an interaction between sentence length and sentence type ($F(1,58)=10.80$, $MSE=0.20$, $p<.01$). As shown in Figure 3(ii), this indicated that all women performed better on pregnancy-related short sentences than on other short sentences ($t(59)=2.86$, $p<.01$), but their performance on long sentences did not differ as a function of sentence type ($t(59)=0.98$, $p>.1$).

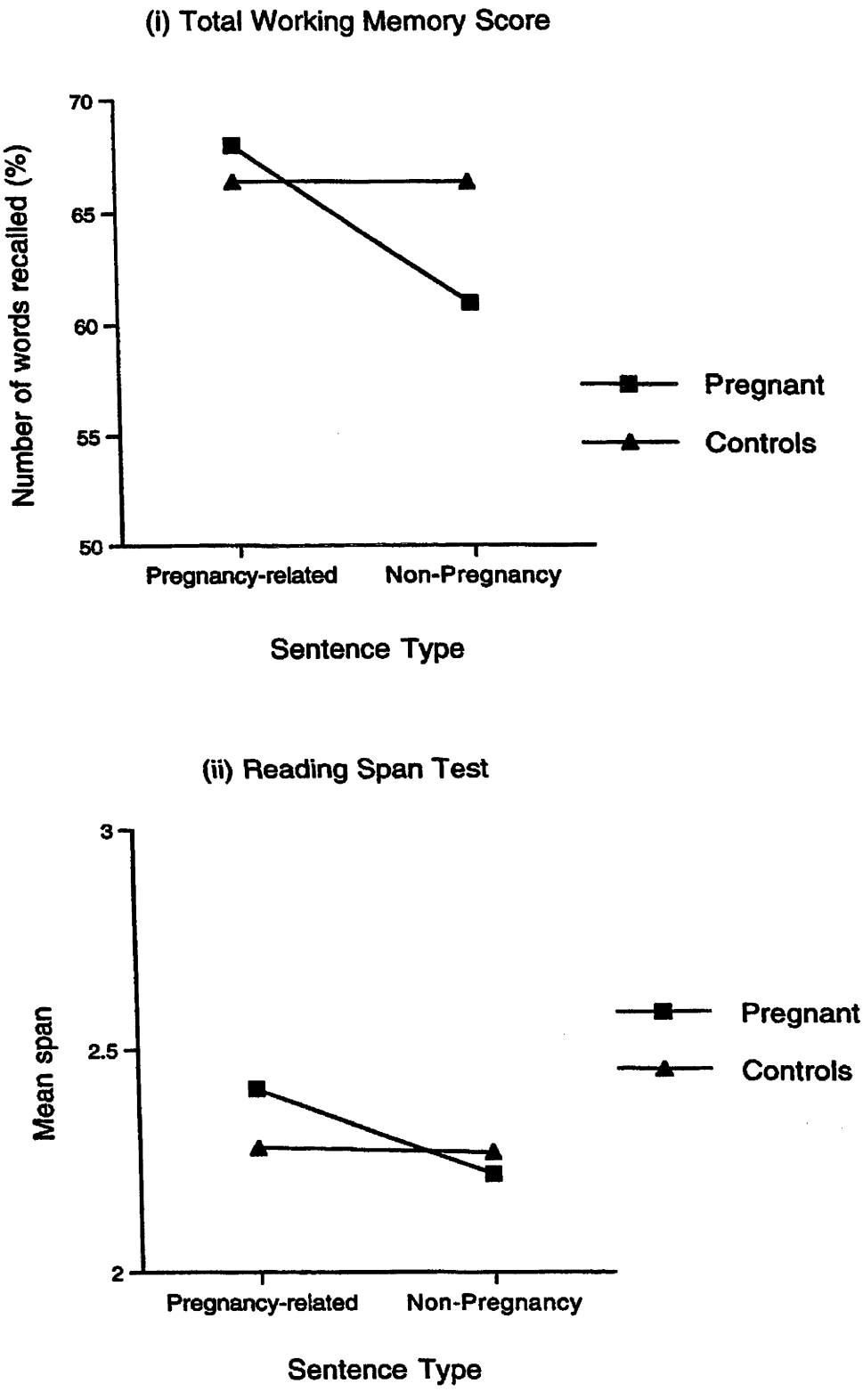

Figure 4. Interaction of pregnancy status and content of sentence for (i) total working memory score, and (ii) reading span test.

There were no main effects for pregnancy status ($F(1,58)<1$) or sentence type ($F(1,58)=2.09$, $MSE=0.31$, $p>.1$), nor were there any other interaction effects (pregnancy status by sentence type: $F(1, 58)=1.47$, $MSE=0.31$, $p>.1$; pregnancy status by sentence length: ($F(1,58)=1.49$, $MSE=0.25$, $p>.1$; pregnancy status by sentence type by sentence length: $F(1,58)<1$). This analysis indicated that pregnant women did not differ from controls in any way on reading span, although the pattern of results was similar to that found for the total WM score (see Figure 4 (ii)).

Correlations between working memory performance and possible confounding factors

The relationships between the total WM score and levels of depression, anxiety, and sleep loss were examined. As shown in Table 10, depression, anxiety, and sleep loss were not correlated with women's performance on this score collapsed over all four conditions (referred to as 'all sentences' in Table 10). This was found for the entire sample and in each group when examined separately.

However, when performance on pregnancy-related sentences and non-pregnancy sentences were examined separately, a significant correlation was found between the score for the pregnancy-related material and anxiety in the entire sample. This reflected that, in all women, lower performance on this material was related to higher anxiety. One possible interpretation of this finding is that there may be a general effect of anxiety on performance as suggested by the pattern of correlations and other findings (e.g., Darke, 1988), but that the pregnancy-related condition was more sensitive to disruption by anxiety than the non-pregnancy condition.

Table 10
Correlations between the Total WM Score and Other Variables

	Potential Correlates of Performance			Self-Perceptions of Memory	
Total WM score[a]	Depression (Non-somatic)	Anxiety (State)	Sleep Loss[d]	Working Memory	General Memory
All sentences[b]					
All Participants	.07	-.22	-.01	.05	.05
Pregnant	.07	-.15	.18	.02	-.05
Controls	.13	-.30	-.07	.06	.10
Pregnancy-related[c]					
All Participants	.05	-.26*	.09	.01	.03
Pregnant	.01	-.22	.20	-.03	-.01
Controls	.06	-.27	.02	.07	.09
Non-Pregnancy[c]					
All participants	.07	-.13	-.09	.07	.06
Pregnant	.10	-.05	.20	-.06	-.08
Controls	.18	-.27	-.16	.03	.08

Note. Values are Pearson's correlation coefficients, unless otherwise stated. WM = Working memory. [a] N=60 for all participants; n=30 each for pregnant and control groups. [b] Includes all four sentence conditions (short/long/pregnancy/non-pregnancy). [c] Sentences are collapsed over short and long sentences. [d] Spearman's rank correlation coefficient.
*p<.05.

Another possible explanation is that anxious individuals may have interpreted pregnancy-related material as threatening (e.g., deformed, breech), but not have done so for the non-pregnancy material (e.g., errand, pledge). This is consistent with other research that indicates that personally threatening words interfere with the performance of anxious individuals (Mathews & MacLeod, 1985). It is also possible that, in consideration of the large number of correlations performed, this finding is simply due to a Type I error.

Correlations between working memory performance and self-perceptions of memory

There was no evidence of an association between self-reports of memory functioning (working memory, general memory) and working memory performance as measured by the total WM score (see Table 10). This held for 'all sentences', and, separately, for pregnancy-related and non-pregnancy sentences.

Methodological Issues

An unexpected finding on the working memory task was that, among both pregnant women and controls, recall was better for pregnancy-related material than for non-pregnancy material in the 'short' condition. Although this bias was expected for pregnant women, it was not expected for controls. One interpretation of this result is that it reflects a general response bias for pregnancy-related material. However, if this was the case, the effect should also be present in the 'long' condition, which it was not. Rather, the effect suggests that the two sets of short sentences (pregnancy-related vs. non-pregnancy) were not comparable in difficulty, despite being matched on sentence length, target word length, and target word frequency. Although this is an undesirable effect, because all participants were exposed to the same stimuli, this effect does not compromise the findings in relation to group differences.

In future, comparable sets of materials might be obtained by matching the sentences on other sentence characteristics, such as syntactic structure, word-type within sentences (possibly, indicated by word frequency), and sentence length (measured by overall number of syllables within a sentence, rather than number of words). It should be noted that different sources of task complexity are not

necessarily equivalent, and different outcomes may result depending on how this is defined (see Gick et al., 1988).

Summary and Conclusion

Using either the total WM score or the reading span, no overall group difference in working memory performance across all four conditions was observed. However, the performance of pregnant women was modified by the content of the material using the total WM score. This effect suggested that the pregnant women had marginally better memory for pregnancy-related material, and marginally worse memory for non-pregnancy material. A similar pattern was revealed using the reading span, but failed to reach significance. This may be because this measure was less sensitive to low and middle scorers. While these findings provided weak evidence for a content specificity effect, suggesting that pregnant women may have a selective focus on pregnancy-related material, the evidence did not conclusively show this effect. There was no evidence that working memory performance was related to non-somatic depression or sleep loss. While anxiety was related to performance, this occurred in both groups of women.

Although there are no comparable published studies of working memory in pregnant women studied alone, these findings are consistent with reading span findings for a combined group of pregnant women and new mothers (Casey et al., 1998). Although one finding suggests there is a working memory deficit in pregnant

women on a backward digit span task (Janes et al.. 1998), this has not been confirmed by findings of Casey et al. (1998) (P. Casey, personal communication, October 22, 1998).

Finally, this experiment also confirmed a discrepancy between subjective and objective memory deficits. Possible reasons for this discrepancy will be discussed in the final chapter.

Chapter 6

Recognition Memory and the Content Specificity Effect

6.0 Introduction

The investigation of a possible selective memory bias during pregnancy described in Chapter 5 was prompted by the findings of Christensen et al. (in press) which demonstrated a content specificity effect on a recognition test for incidentally learnt material. In that study, pregnant women had enhanced memory for pregnancy-related material compared to controls. Here, I examine whether this content specificity effect can be replicated on a similar type of recognition test for incidentally learnt material.

The recognition test was based on material given in the prospective memory task (see Chapter 4). In that task, participants were instructed to make word-associations and press a key upon encountering certain words. Amongst the list of words seen, were a set of pregnancy words and neutral words used as targets for the recognition test. At the end of the task, women were asked to identify these 'old' target words in a list containing 'new' distractor words. Although the findings of Christensen et al. (in press) suggest that pregnant women should have enhanced memory for pregnancy words, but intact memory for neutral words, relative to

controls, other patterns of results would also be consistent with a content specificity effect. For example, pregnancy may be associated with intact memory for pregnancy words, but impaired memory for neutral words. In fact, this pattern would be more consistent with the proposal of a selective memory deficit in pregnancy. In addition, one problem in the study by Christensen et al. (in press) was that the finding of superior memory for pregnancy-related material may have been due to a high rate of false alarms, but this was not assessed.

It should be noted that due to the nature of the presentation of stimuli for the recognition test, this test is not identical to that used in the Christensen et al. (in press) study. In the present study the target words were embedded in a prospective memory task/word-association task which required semantic processing, whereas the previous study used an attention task which required reading words aloud. Other research has found that depth of processing is important to learning, with words that have been processed only in terms of superficial visual appearance being poorly retained, and words that have been processed with deeper or richer semantic encoding are better retained (Craik & Lockhart, 1972).

6.1 Methods

6.1.1 Participants

All participants described in Chapter 2 completed this experiment.

6.1.2 Materials and Procedure

The stimuli for the recognition test included 20 target words (10 pregnancy words and 10 neutral words) that were mixed with 142 non-target words that were seen as part of the prospective memory task described in Chapter 4. Each word appeared for 3 seconds. There were no instructions to learn the words (i.e., incidental learning), but the prospective memory task required participants to generate word associations for each word, and also to press a key upon encountering target words from 4 different semantic categories. Thus, semantic encoding instructions were used at study.

The presentation of the list was followed by a delay of five minutes in which participants were given a number of questionnaires to complete. Participants were then given a response sheet for the recognition test. This consisted of the 20 target words and 20 distractor words (10 'new' pregnancy words and 10 'new' neutral words) that had not previously been seen in the studied list. The distractor words were matched to the target words on word frequency (Kucera & Francis, 1967) and syllable length. Thus, a total of 40 words were displayed in random order using three columns on an A4 size sheet of paper. The set of targets and distractors can be found in Appendix E. Participants were instructed to place a tick next to any words that they remembered from the previous list, but also to refrain from guessing. There was no time restriction on the completion of responses.

6.1.3 Design

The design was a 2x2 factorial. The between-subjects factor was the pregnancy status of the participants (pregnant or non-pregnant). The within-subjects factor was the type of material presented for recognition (pregnancy-related content or neutral content).

6.2 Results and Discussion

Three indexes of performance on the recognition test were used: hit rate, false alarm rate, and corrected recognition rate. The hit rate refers to the number of old words correctly identified as old, calculated as a percentage. The false alarm rate is the number of new distractor words falsely identified as old. The corrected recognition rate accounts for guessing by subtracting the false alarm rate from the hit rate. Means of each measure for pregnancy-related words and neutral words among pregnant women and controls are shown in Table 11.

Table 11
Recognition Memory (%) as a Function of Pregnancy Status and Word Type

	Hit Rate		False Alarm Rate		Corrected Recognition Rate[b]	
Word Type/Group[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pregnancy-related						
Pregnant	93	11	1	4	92	11
Controls	86	17	5	9	81	21
Neutral						
Pregnant	86	13	3	5	83	14
Controls	80	19	5	7	75	20

Note. All values are mean percentages. [a] $n = 30$ for each group.
[b] Corrected recognition rate is equivalent to the Hit rate minus False alarm rate.

An analysis of the corrected recognition rate revealed a main effect for pregnancy status ($F(1,58)=5.16$, $MSE=470.80$, $p<.05$). As shown in Figure 5, this reflected that pregnant women had better recognition memory than did controls irrespective of the type of word. There was also a main effect for word content ($F(1,58)=14.92$, $MSE=118.16$, $p<.01$), which indicated that both groups remembered pregnancy words better than neutral words. Finally, there was no interaction effect for pregnancy status by word content ($F(1,58)<1$). An analysis with extreme outliers removed showed identical results.

In addition, a discrimination index (hits-false alarms) and bias index (false alarms/(1-discrimination index)) (Snodgrass and Corwin, 1988) for two-high-threshold theory were calculated. (Hit and false alarm rates are corrected "by adding 0.5 to each rate and dividing by N+1" for consistency with other recognition formulas). As found for the corrected recognition rate, pregnant women had better discrimination than did controls ($F(1,58)=5.16$, $MSE=0.04$, $p<0.05$). There were no group differences in response bias ($F(1,58)<1$).

To examine whether the results could be attributed to correctly identifying old words or new words, separate analyses were calculated for the hit and false alarm rates. In general, the patterns of results could be attributed to group differences in hit rates. The false alarm rate was low in both groups (Mann-Whitney $U= 382$, $p>0.1$). Although there were no group differences on the hit rate, the trend suggested that pregnant women had a higher hit rate ($F(1,58)=3.57$, $MSE=355.09$, $p=.06$).

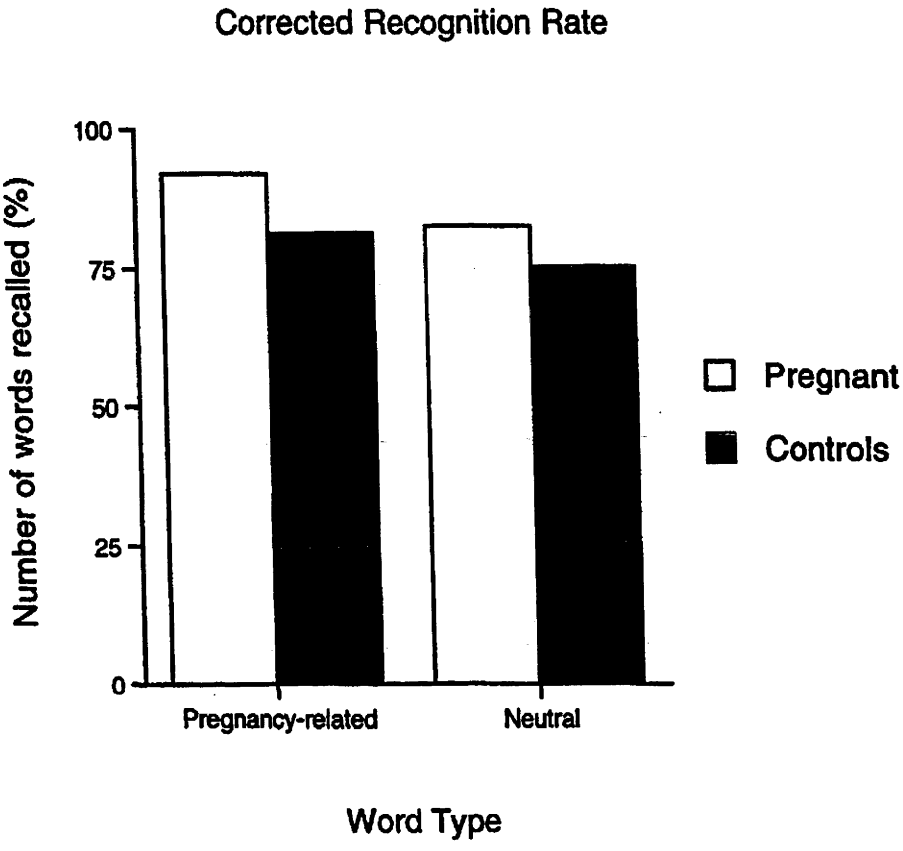

Figure 5. Recognition memory as a function of pregnancy status and word type.

As found for the corrected recognition rate, there was a main effect for word type ($F(1,58)=11.35$, $MSE=111.64$, $p<.01$), indicating that pregnancy words were remembered better than non-pregnancy words. There was no interaction effect for pregnancy status and word content ($F(1,58)<1$).

Associations between recognition memory and self-perceptions of memory

Correlations between the corrected recognition rate and self-perceptions of memory (i.e., retrospective memory and general memory) are shown in Table 12. As found in the two previous chapters, performance was not correlated with self-perceptions of memory.

Table 12
Correlations between Recognition Memory and Other Variables

	Potential Correlates of Performance			Self-Perceptions of Memory	
Corrected Recognition Rate	Depression (Non-somatic)	Anxiety (State)	Sleep Loss[a]	Retrospective Memory	General Memory
All participants (N=60)	.18	-.02	-.09	.05	.16
Pregnant (n=30)	.11	-.05	-.17	.01	.12
Controls (n=30)	.16	.04	-.19	.22	.31

Note. Values are Pearson's correlation coefficients, unless otherwise stated. All *ps* >.05.
[a] Spearman's rank correlation coefficient.

Summary and Conclusion

The main finding of the recognition test is that pregnant women showed better overall memory than did controls. Although pregnant women had better memory for pregnancy-related words, as found in the study by Christensen et al. (in press), they also, unexpectedly, had better memory for neutral words. These results are somewhat consistent with previous studies (e.g., Brindle et al., 1991; Sharp et al., 1993; Silber et al., 1990) in that none of these studies have found deficits in recognition memory of 'neutral' material during pregnancy. However, no other study has reported superior recognition memory for 'neutral' material in pregnancy. These studies did not manipulate the content of material in the tests.

The finding of overall superior recognition memory in pregnant women is also surprising given that pregnant women may well have been at a disadvantage on the recognition task. This is because pregnancy-related words may have had higher word frequency for pregnant women (because of their recent exposure to such material), and such words are known to be more difficult to recognise compared to low frequency words (e.g., Gillund & Shiffrin, 1984).

The results for the recognition test failed to support the notion of a content specificity effect during pregnancy. In pregnant women, there was no evidence that memory was affected by the nature of the material. One possible explanation for the lack of this effect may relate to the presence of a ceiling effect. On the pregnancy-related set of words, pregnant women were performing at ceiling levels, such that 80% had perfect or near recognition scores, even after correcting for false alarms.

This ceiling effect was not found in the recognition test of Christensen et al. (in press). The present finding may be attributable, in part, to the use of semantic encoding, which encouraged better retention of the material. It seems quite possible that a more sensitive or difficult recognition memory task, such as that used by Christensen et al. (in press), would reveal superior memory for pregnancy-related words among pregnant women.

The unexpected finding that all women had better memory for pregnancy-related words than for neutral words needs to be explained. As suggested by Christensen et al. (in press), who also found this effect, it may be due to an overall response bias towards pregnancy-related words. This may be related to women's awareness that the study concerned pregnancy. Furthermore, the sets of pregnancy-related and neutral words may not have been of comparable difficulty level. The pregnancy-related words may have been easier to remember because they formed a semantic category. This effect could be avoided by constructing a semantic category of neutral words. While this effect is undesirable, as both groups were exposed to the same stimuli, it should not influence the findings relating to differences between the groups.

This chapter has shown that a discrepancy exists between women's reports of memory deterioration in pregnancy and their objective memory performance on an explicit memory test as found by most other pregnancy-memory studies. However, in contrast to other studies, the discrepancy arises because objective findings indicated

that recognition memory was superior during pregnancy, not unimpaired. In women's reports, there is no indication whatsoever that they perceived that any aspect of their memory to have improved.

Chapter 7

General Discussion

7.0 Introduction

As outlined in the introduction of Chapter 1, there is a major disparity between women's subjective reports of their memory functioning during pregnancy and their performance on objective tests of memory. In chapters 2 to 6, I examined the nature of memory complaints in pregnancy, and investigated a number of possible bases for an objective memory deficit. Here, I discuss these findings, their limitations, and possible future directions for the study of subjective and objective memory functioning in pregnancy.

7.1 Summary of Results

The pregnant women in this study (see Chapter 2) were primiparous and in third trimester. Compared to a group of non-pregnant control women of the same age and education level, pregnant women were no more anxious or depressed on the non-somatic BDI scale. As expected, the pregnant women reported more somatic symptoms of depression, including sleep disturbance. These symptoms were attributed to pregnancy, rather than depression.

On the self-report questionnaires (see Chapter 3), the pregnant women perceived that their memory was subjectively worse during the pregnancy than it was under normal circumstances, whereas the control group perceived no changes in their memory. Pregnant women perceived that the deterioration had occurred in all domains of memory that were assessed, including retrospective memory, prospective memory, and working memory. These patterns were generally validated by informant reports, although the informants perceived the memory deterioration during pregnancy as being somewhat weaker than did the pregnant women themselves. Memory complaints in pregnant women were related to non-somatic depression, but not to anxiety or sleep loss.

On the objective tests of memory performance, there was no evidence to suggest an objective deficit in prospective memory (see Chapter 4), working memory (see Chapter 5), or recognition (see Chapter 6) during pregnancy. In fact, there was evidence that pregnant women had *superior* recognition memory. Across the three experiments, it was generally found that memory performance in both pregnant women and controls was not related to non-somatic depression, anxiety, or sleep loss.

It should be noted that these subjective and objective memory results are specific to a sample of primiparous women in third-trimester, who may not be representative of the general population of pregnant women. As noted in Chapter 2, the participants were recruited from private hospitals, and the majority of these were highly educated and in professional or managerial occupations. Replication of the

current findings is required in a more representative sample of pregnant women, including women recruited from public hospitals, who are likely to vary from the present sample on socio-demographic characteristics.

7.2 Mechanisms underlying Objective Memory Deficits in Pregnancy

Three mechanisms were proposed to underlie memory deficits in pregnancy. Overall, the pattern of experimental results failed to support any of these.

Inefficient self-initiated retrieval. The present results did not support the notion of inefficient SIRP (Craik, 1986) in pregnancy. This finding assumes that the typicality manipulation used in the prospective memory task reflects changes in the demand on self-initiated retrieval, a case that was supported by the finding that performance declined with decreasing typicality. Thus, the failure to find any pregnancy-related deficits on the prospective memory task, especially the atypical condition, suggests that such processes were not disrupted during pregnancy.

This is the first study to assess SIRP and prospective memory during pregnancy. Although it finds no evidence for a deficit on one type of prospective memory task (event-based, short-term), the possibility exists that deficits might occur on long-term or time-based tasks (Morris, 1984). These and other objective tests may be more sensitive to a disruption of SIRP or a prospective memory deficit in pregnancy.

Inefficient working memory. The results failed to support the possibility of inefficient working memory in pregnancy. There was no evidence of such deficits, despite using a complex condition that taxed working memory resources. The present study suggests that pregnancy should not affect women's ability to simultaneously process and store information in complex cognitive tasks involving working memory, particularly in comprehension. Although no other studies have reported on reading span performance in pregnant women, there is mixed evidence for a deficit on backward digit span in pregnancy (P.Casey, personal communication, October 22, 1998). Thus, despite finding no evidence for a deficit on a verbal measure of working memory, this does not rule out the possibility that a deficit might be found on non-verbal measures. In fact, non-verbal measures may reflect different aspects of working memory, and perhaps these aspects are more sensitive to a deficit in pregnancy (see Jurden, 1995).

Content specificity effect. There was some support for a content specificity effect in pregnancy. Evidence from the working memory test indicated that the performance of pregnant women was modified by the content of the material such that they performed marginally better on pregnancy-related material, and marginally worse on non-pregnancy material. Although this interaction effect was only significant on the total WM score, a similar pattern was found on a more traditional measure resembling reading span. However, results for the recognition test did not show a content specificity effect in pregnancy. In this task, pregnant women showed better overall memory, rather than a memory bias specific to pregnancy-related words.

The only two studies investigating content specificity in pregnancy have found inconsistent evidence for this hypothesis. It has been found on some tests (recognition test – Christensen et al., in press; working memory test - present study), but not others (dot-probe attention test – Christensen et al., in press; recognition test – present study). Furthermore, the two studies show conflicting results on similar (but not identical) recognition tests, with the present study failing to find an effect. This may have been due to the fact that differences in false alarm rates were taken into account in the present study. However, the failure to find a content specificity effect in the present study is most likely a result of a ceiling effect as performance on the pregnancy-related material was almost perfect in pregnant women. Although the notion of a content specificity effect has not been disconfirmed by these results, there does not seem to be sufficient data on the content specificity effect to draw any definite conclusions about its role in memory changes in pregnancy.

Despite the lack of evidence for content specificity, the idea that memory deficits in pregnancy may be related to selectively focussing on pregnancy-related activities is compelling. Further research could be undertaken to investigate whether a content specificity effect is present on more difficult cognitive tests, particularly ones that are not susceptible to a ceiling effect. Such studies might employ free recall tests, which are less likely to show a ceiling effect and may be more sensitive to a content specificity effect than are recognition tests. It has been noted that recognition tests may be less sensitive because there are sufficient alternative cues available that may override the use of a weaker pregnancy-related cue (Williams et al., 1988).

However, previous pregnancy-memory studies have found little evidence of an objective deficit on free recall tests involving 'neutral' material, although the content has not been manipulated to include pregnancy-related material (Brindle et al., 1991; Christensen et al., in press).

Another possibility for further research would be to study performance on divided-attention tests since these are both difficult and can detect subtle changes in performance. These tasks could also be used to investigate changes in attention that occur when pregnancy-related or -unrelated material is presented. For example, performance on a primary task (such as monitoring a stream of digits to be labelled as odd or even) may become impaired in pregnancy when a secondary task is pregnancy-related as opposed to being neutral. Pregnant women would be expected to divert their attention to the pregnancy-related task, thus interfering with their performance on the primary task.

7.3 Relationships between Memory Deficits and Depression, Anxiety, and Sleep Loss

Despite the proposal that increases in depression, anxiety, and sleep loss may contribute to objective memory deficits in pregnancy, there was no evidence to suggest that this had occurred. Pregnant women did not show increased levels of depression or anxiety, nor did they show deficits on the objective memory tests. Furthermore, performance on most of the objective tests was not correlated with depression, anxiety, or sleep loss. The only exception to this finding was that higher anxiety in all participants was related to poor working memory for pregnancy-related

material. As noted in Chapter 5, this may have occurred because the content of pregnancy-related sentences may have evoked emotional responses in more anxious individuals. Alternatively, given the large number of correlations performed, this result may simply be due to a Type I error. Overall, there was no indication that depression, anxiety, or sleep loss had any effect on the cognitive performance of pregnant women.

The possibility that depression, anxiety, and sleep loss might be linked to subjective memory deficits in pregnancy was also examined. Despite suggestions that greater depression and anxiety in pregnancy may be related to memory complaints, pregnant women did not show higher levels of depression or anxiety. An interesting finding was that, in pregnant women, depressive symptoms were related to memory complaints, whereas in controls, there was no relationship. It is possible that depressive symptoms may have a different effect on women during pregnancy, leading to the report of other symptoms.

Memory complaints were not related to sleep loss, despite higher levels of sleep loss among the pregnant women. The findings of greater sleep loss in pregnant women confirm others (Christensen et al., in press; Condon et al., 1991). No other study has reported on the relationship between sleep loss and memory complaint in pregnancy. However, contrary to the present findings, a study of pregnant women and new mothers has found that perceived sleep loss was related to memory complaint (Janes et al., 1998). Overall, there was little evidence to suggest that mood

and sleep loss were associated with the memory complaints made by pregnant women.

7.4 A Mechanism for Enhanced Memory in Pregnancy

One outcome of the recognition test, which was designed to address content specificity, was that pregnant women had better recognition memory than did the controls. With no other findings of better recognition memory in pregnant women, except on pregnancy material (Christensen et al., in press), this new result needs to be replicated. The possibility that women may have enhanced memory in pregnancy is consistent with recent hormonal research which suggests that hormones, particularly estrogen, may improve some aspects of memory performance (e.g., Sherwin, 1994). A hormonal explanation would predict improvement in other areas of memory, such as recall. However, this has not been found (Brindle et al., 1991; Christensen et al., in press; Sharp et al., 1993).

The role of hormonal factors in memory changes during pregnancy has not been adequately investigated. Given that this finding of superior memory in pregnancy is at odds with all other subjective and objective findings on the memory-pregnancy relationship, further evidence of this effect is required before undertaking an extensive hormonal study.

7.5 Findings of Present Study with respect to other Objective Studies

This study and that of Christensen et al. (in press) have failed to demonstrate any objective deficits in pregnant women on a wide range of memory tasks, including recall, recognition, prospective memory, and working memory. This is in contrast with the findings by other investigators, which have found mixed evidence for a memory deficit (Brindle et al., 1991; Eidelman et al., 1993; Jarrahi-Zadeh, 1969; Sharp et al., 1993; Silber et al., 1990). The present study and that of Christensen et al. (in press) measured depressive symptoms, showing that pregnant women were no more depressed than controls, whereas the other studies with evidence of memory deficits in pregnancy have not controlled for depressive symptoms. Indeed, one study has found that memory deficits occurred in pregnant women with mood changes, but not in other pregnant women (Huppert & Whittington, 1997). Thus, it is possible that higher levels of depression in pregnant women are responsible for the deficits observed, rather than pregnancy per se. One conclusion of this study, as for Christensen et al., (in press), is that at least for non-depressed pregnant women, memory performance is unimpaired.

7.6 Discrepancy between Subjective and Objective Measures

One of the main findings of the present study was that self-reports of memory deterioration in pregnancy did not agree with the findings for objective memory performance. Contrary to the self-report data, which indicated that pregnant women perceive deterioration in different domains of memory, there was no evidence of any

objective deterioration in their performance on any of the objective tests for prospective memory, working memory, or recognition memory. Furthermore, memory perceptions correlated poorly or not at all with objective measures of performance. These findings confirm the findings of other investigators (Brindle et al., 1991; Christensen et al., in press), despite using a more comprehensive memory perception questionnaire designed to tap the specific domains of memory that were objectively tested.

There are several possible reasons for this discrepancy. One is that the objective tests may be insensitive to a genuine cognitive deficit. Another is that there is no objective cognitive deficit present in pregnancy. In this case, women's memory perceptions are thought to be inaccurate.

Objective tests are insensitive to a genuine deficit. If the self-reports are considered to be accurate assessments of women's level of everyday memory functioning, a case which is supported by informant reports, then it may be that the cognitive tests have lacked sensitivity to a specific type of memory deficit. There are a number of reasons why this study and others may have been unable to demonstrate this deficit.

One possibility is that the tests used here did not tap the specific aspect of memory that is impaired in pregnancy. As noted earlier there are other forms of prospective memory that have not been assessed here. Likewise, working memory

can be measured by both verbal and nonverbal tests. It is unlikely that one test could adequately capture the entire memory construct.

It is possible that, despite the range of different memory domains assessed to date, the affected domain has not been examined. One area that has not been addressed in previous studies is semantic memory, which relates to memory for knowledge. However, there is little evidence that women complain of deficits in this area. Given that there are few studies on implicit memory, and these have mixed findings (Brindle et al., 1991; Sharp et al., 1993; cf. Casey et al., 1998), this is one possible avenue that could be pursued.

Another possible explanation for the failure to find objective deficits is that the objective tests may not be appropriate for detecting the kind of deficit that occurs in everyday memory activities. This may relate to differences in women's attention in the laboratory compared to the normal environment. Brindle et al. (1991) proposed that, in everyday activities, pregnant women are preoccupied with pregnancy and childbirth, thus producing inattention to other tasks. However, when placed in a laboratory and given instructions to learn words as on typical memory tests, pregnant women increase their attentional effort, and, in doing so, eliminate any deficit. A prediction made from this argument was that deficits should appear when women are not required to focus their attention on the task (i.e., incidental memory tests), but there is little evidence for this (Christensen et al., in press; Sharp et al., 1993). These findings are not consistent with the argument that pregnant women increase their attentional effort to overcome memory deficits.

In a variation on this explanation, I propose that the objective tests may suppress the pregnancy-related thought patterns that are responsible for the presence of deficits in everyday life. Based on the concept of stimulus-independent (SI) thoughts (Teasdale, Proctor, Lloyd, & Baddeley, 1993; see also Teasdale & Barnard, 1993), it is reasoned that memory deficits occur in pregnant women because pregnancy-related SI thoughts take up processing resources in the working memory system leaving fewer resources to devote to other tasks. However, in demanding situations, such as a laboratory task, these SI thoughts are suppressed (Teasdale et al., 1993). This allows for working memory resources to be redirected to the memory test being performed, providing adequate resources for its successful completion. Hence, no deficit is observed on laboratory tests. However, against this argument, the use of incidental memory tasks in other studies, which would presumably allow for SI thoughts, have not been able to reveal deficits (e.g., Sharp et al., 1993). Perhaps, even these tests do not offer an adequate measure since the participation in such traditional laboratory tests itself may be sufficient to suppress the naturally occurring SI thought processes.

A possible avenue for further research is to explore women's memory functioning in situations where they have the opportunity to engage in SI thoughts, and to also measure the frequency and content of these thoughts. One method that could be used to encourage naturally occurring SI thoughts is to familiarise women with cognitive tasks so that they become routine, and, in doing so, allow for SI thoughts. The first step, however, may be to examine the nature of SI thoughts in

pregnant women to ascertain whether this is a possible explanation. This might be done in a 'beeper' study in which pregnant women and controls record their thoughts at different random times of day in response to a beeper. If the findings suggested that pregnant women had the same rate of SI thoughts as controls, it would discount the idea that this type of extra processing occurs in pregnancy.

No objective deficit, and subjective reports inaccurate. Alternatively, self-report measures may simply reflect inaccurate perceptions, rather than an objective deficit per se. There are several reasons to suspect this is the case. As suggested in Chapter 1, inaccurate self-reports may stem from affective symptoms, particularly depression (e.g., O'Hara et al., 1986; Smith, Peterson, Ivnik, Malec, & Tangalos, 1996; West et al., 1984). However, this argument is not supported here because the pregnant women were not more depressed than controls, and there was no relationship between affective symptoms and performance. This was also found by Christensen et al. (in press). Almost no other study of subjective memory deficits in pregnancy has commented on this relationship.

A more viable possibility is that false perceptions of memory deficits in pregnancy reflect socially conditioned beliefs about memory changes during pregnancy (Casey et al., 1998; Christensen et al., in press). Cultural stereotypes of pregnant women as forgetful may lead to the belief that memory should deteriorate in pregnancy, and in turn lead women to overestimate memory problems. In memory research on non-pregnant individuals, there is evidence that memory perceptions are influenced by such factors as one's beliefs about past memory experiences and

stereotypes (for review, see Herrmann, 1990). It is also noted that false beliefs about memory decline with age are thought to be responsible for unfounded memory complaints in older populations (Rabbitt & Abson, 1990).

However, the finding that informants confirm women's perception of memory deterioration in pregnancy in this and other studies (Christensen et al., in press; Condon & Ball, 1989) suggests that the women may be reporting a genuine memory deficit. In other research, informant reports have been found to predict memory performance in elderly spouses (see Zelinski et al., 1990), indicating that informants can provide a valid measure of the subject's memory ability. On the other hand, informants may be influenced by the women's memory complaints or share their social conditioned beliefs about the effects of pregnancy (see Christensen et al., in press). In fact, one study has found that men are more likely to hold negative stereotypical views about pregnant women in relation to their work performance than are women (Halpert, Wilson, & Hickman, 1993). One possible step that might be taken in future studies to improve the accuracy of memory perception questionnaires is to provide anti-stereotype training to both individuals and their informants. Although the participants in the present study were informed that the evidence regarding memory changes in pregnancy was unclear, extensive information about stereotypical myths and scientific evidence for cognitive changes in pregnancy may be a more effective in altering false beliefs.

Two general points about the accuracy of memory questionnaires are warranted. Inaccuracies in self-reports may stem from the individual's lack of

knowledge about memory structures, and their own memory processes. For example, Shlechter et al. (1990) found that when memory ratings were taken before and after a diary study of memory failures, only the post-diary memory ratings were correlated with memory failures, suggesting that the firsthand feedback helped to improve memory perceptions. Thus, the accuracy of memory self-perceptions might be improved by giving feedback and relevant experience. This may also be effective in reducing false beliefs about memory performance in pregnant women.

Another possible source of inaccuracy in memory perception questionnaires relates to the design of such questionnaires. Many of the traditional memory perception questionnaires tap perceptions of performance on everyday activities (e.g., remembering names), not performance on memory tasks (e.g., recall of a list of random words). The correspondence between subjective and objective measures might be improved by assessing self-perceptions of performance on a particular task (e.g., remembering names), and then testing performance on that task (e.g., test of face recognition). Thus, the validity of the questionnaires might be improved by redesigning memory perception questionnaires to include more specific questions that reflect processes that can then be tested in objective tasks. Alternatively, the use of everyday memory questionnaires might be coupled with an everyday task simulation. This is a laboratory task that bears some resemblance to an everyday memory experience.

While this study attempted to compare specific perceptions of prospective memory and working memory to objective performance in these domains, the

memory perception questionnaire tapped some aspects of prospective memory and working memory that were not tested by the objective memory tests. For example, the questionnaire item 'remembering appointments' would be more comparable to a long-term, time-based prospective memory task, rather than the short-term, event-based task used here. Thus, refinement of the memory perception questionnaire used here is warranted.

However, several investigators have noted that typical memory perception questionnaires might have greater predictive validity when used in participants who are informed about their memory processes (Herrmann, 1984; Morris, 1984). A study by Herrmann, Grubs, Sigmundi, & Grueneich (1983) (as cited in Herrmann, 1984) found that performance on laboratory tests correlated with memory perceptions of ability on these laboratory tests taken after completing the laboratory tests, but not to memory perceptions taken prior to objective testing. This suggested that a greater problem for the validity of such questionnaires might not be the design, but the inadequate self-knowledge of respondents about their memory, and memory processes generally. In pregnant women, this would be compounded by false expectations of memory deterioration during pregnancy.

In the absence of clear evidence for objective memory deficits, further research should examine the nature of complaints about memory in pregnancy more carefully. This may point to non-memory factors, such as belief patterns about memory functioning in pregnancy, as the source of these complaints.

Possible effects of negative beliefs about memory. A question that arises from the finding that women perceive that their memory has deteriorated is whether these perceptions have any important consequences? In other research, there is evidence to suggest that perceptions of memory can change behaviour generally (e.g., avoiding certain tasks because of lack of confidence in one's memory ability; see Sehulster, 1981). Such false perceptions might lead pregnant women to avoid memory tasks, choose inappropriate memory strategies, and exert less effort. It may also lead to increased dependency on others, depression, and anxiety. Given that much of the evidence suggests that such beliefs have no basis in objective deficits, it would be beneficial to correct such beliefs, to ensure that negative behavioural effects do not occur.

7.7 Concluding Remarks

Most pregnancy studies report that women perceive deterioration in their memories during pregnancy, but few studies have been able to confirm this on objective tests of memory. Despite their self-reports of memory deterioration, the pregnant women in this study did not show deficits in their performance on objective measures of prospective memory, working memory, and recognition memory. In fact, pregnant women showed better recognition memory. There was weak evidence of a content specificity effect in pregnancy, which reflected marginally superior memory for pregnancy material, and marginally impaired memory for non-pregnancy material. In general, the lack of objective memory deficits in pregnancy suggests that there may be a non-memory basis for memory complaints in pregnant women. The possibility

that greater depression during pregnancy contributes to these complaints in pregnant women was disconfirmed.

Further research might address whether an objective deficit originates in non-memory cognitive areas that feed into memory performance, such as attention or SI thoughts. Perhaps, a more promising direction would be to investigate whether women's reports are influenced by negative beliefs about cognitive deterioration during pregnancy. The correction of such negative beliefs may result in greater agreement between measures of subjective and objective memory functioning in pregnancy.

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Appendices

Appendix A

Table A1. Items of the Memory perceptions questionnaire

Memory Area	Question
General	How would you rate your memory (over the last few weeks/under normal circumstances) in terms of the kinds of problems that you have had?
	Looking at the list below, during the last few weeks/under normal circumstances how often have the following presented a problem for you:
Retrospective	Forgetting names Forgetting where you put things Forgetting phone numbers you have just looked up Forgetting phone numbers that you use frequently Forgetting things people tell you
Prospective	Forgetting birthdays or important dates Forgetting appointments Forgetting to do things, like lock the door or pay bills
Working	Being unable to learn or process new things Being unable to do many things at the same time Being unable to problem solve or calculate things quickly
Use of Memory Aids	In the last few weeks, how often would you make a list or use a memory aid (such as an appointment book) to help you to remember things you needed to do?

Appendix B

Sample diary and examples of entries

First section: Intentions and actions?

"I was intending to pack some baby things for a friend of mine, but I forgot"

"I realised that I had forgotten a friend's birthday".

Second section: Consequences?

"I had to get up early to pack the baby things"

"I had to send a belated birthday card".

Third section: Circumstances?

"It was late at night and I was very tired"

"I returned from a busy weekend".

Appendix C

Table C1. Examples of target words for prospective memory test across category, list and item typicality

		List A		List B	
Category	Code	Typical	Atypical	Typical	Atypical
Article of Furniture	1	chair	clock	stool	picture
Type of Fruit	2	apple	fig	pear	coconut
Type of Vehicle	3	bus	van	aeroplane	rocket
Part of a Building	4	ceiling	entrance	roof	corridor

Appendix D

Four sets of sentences and target words for reading span tests

Stimuli
Non-pregnancy, short sentences
Problems start when the cardiac skeleton becomes more dense.
For the study of the brain, many techniques are at hand.
Problems with pumping of blood start when the heart is stiff.
Cardiac patterns may be affected by diseases of the lung.
One therapy involves a reduction in the intake of salt.
After a valve partly closes, a murmur becomes quite loud.
Careful exercise is undertaken to make the heart strong.
Diseases of the heart are related to changes in its pattern at rest.
After a heart attack a person may need nursing from an aide.
A fatal stroke may follow an incident of severe stress.
Extracting tissue for analysis is a biopsy's main goal.
The disability resulting form a stroke has a high public cost.
The relation between age and heart attack is very clear.
Patients who suffer from faintness will sink to the ground.
Hypotension follows from a heartbeat that is slow.
Cardiac patients are checked for changes in their energy stores.
Having a fitness assessment to determine heart output can help.
The contribution of genetic factors in heart disease is not huge.
Sufferers of cardiac arrests are more likely to be males.
Before a heart attack, chest pain provides a crucial hint.
Strokes can have subtle symptoms that are not easily seen.
The symptoms of a stroke usually take place over minutes or hours.
Lifespan is increased when patients use oxygen machines at home.
The incidence of stroke is decreasing in current times.
A heart attack ensues when the muscle comes to a halt.
Cardiac patients may be found in a semi-conscious state.
Some stroke victims respond to medication at higher doses.
Damage is caused when clotting produces a valve block.
High blood pressure causes strained arteries to become weak.
For people in late life, stroke is a common cause of death.
Having a cardiac disorder by itself is very rare.
Infection of heart valves allows muscle disease to take hold.
Coronary bypass surgery is a common and reliable choice.
A common outcome of serious stroke is paralysis on one side.
Frequently a patient will have an unusually rapid pulse.
Pain associated with a heart attack can begin in the left arm.
A coronary spasm may attack patients who are very old.
The heart muscle is partly protected by the surrounding ribs.
Mortality is greater in cardiac patients suffering from shock.
The range of conditions that disrupt the heart's pump action is broad.

Non-pregnancy, long sentences

There are certain types of drugs that help to prevent a cardiac arrest from recurring.
Some types of medication prescribed for stroke are useful in reducing its incidence and mortality.
Serious stroke cases lead to coma and severe physical or mental impediment.
Lowering blood pressure in elderly patients produces many lifestyle and health benefits.
Extrapolation from animal heart experiments to the human situation is misleading.
Apart from medication, other treatments for hypertension include nutrition and exercise management.
Huge increases in the amount of strenous physical output after a cardiac arrest can be dangerous.
Cardiac failure happens when the pumping action of the heart is severely modified.
A feature of a healthy cardiovascular system is that it consists of soft expansile material.
Scanning of the brain is performed so that a diagnosis of stroke can be determined.
Coronary artery disease follows when there is an oxygen supply and demand imbalance.
A high calcium and low sodium diet is one method by which stroke can be prevented.
Medical research has shown that the effect of hypertension on coronary artery diseases is important.
A serious infection accompanied by a fever is a major factor in heart failure precipitating.
The location of brain damage determines whether the stroke patient will recover functioning.
A negative outcome of ageing is that the heart valves increase in thickness and rigidity.
The entire system that the body has to maintain adequate blood supply is extremely elaborate.
Even if it is questionable that someone has had a stroke it is advisable to call the doctor immediately.
Physiotherapy is one discipline that helps restore any lost sensation or movement.
The heart muscle is a dual action pump that has been designed to operate efficiently.
After an attack, patients should do moderate physical exercise as part of cardiac rehabilitation.
Faintness commonly ensues when the amount of oxygen in the blood going to the brain diminishes.
Over half of patients suffering from a stroke have blood pressure levels which are highly elevated.
Heart disease may be affected by factors of obesity and high physical inactivity.
The sudden onset of chest pain is a warning symptom requiring a medical consultation directly.
The lifestyle of a patient should influence the kind of health program that is implemented.
Depending on the location of brain damage, the severity of stroke will vary considerably.
Some signs of a cardiac condition include headaches, blurred vision, slurred speech, and problems with swallowing.
The amount of time between the experience of symptoms and seeking medical advice is critical.
Stroke has similar symptoms to other disorders such as brain tumor or inflammation.
By administering small amounts of morphine, pain relief for cardiac arrest is accomplished.
Improving exercise patterns to alter the course of cardiac disease has suggested by recent evidence.
The human heart is able to alter blood flow to extract oxygen maximally.
A possible problem of major stroke that affects patient recovery is ongoing clot formation.
The study of coronary arteries via radiography is a safe and routine medical technology.
Avoiding a heart attack by changing lifestyle is preferable to treatment of its consequences.
Smoking does not increase the chance of heart disease irrespective of levels of serum cholesterol.
Complete recovery is not guaranteed for cardiac patients selecting to have a bypass operation.
Some protection from heart disease may be afforded by moderate alcohol consumption.
An attack persisting for a few minutes warns that blood circulation is not sufficient.

Pregnancy-related, short sentences

Pregnant women with diabetes may be given additional tests.
The experience of pregnancy can satisfy a mother's needs.
Babies with small organs should be covered and kept warm.
During labour it may be comfortable to hold a chair and squat.
After birth some women should avoid certain types of pills.

Jaundice is treated by exposing the infant to artificial light.
A suture is performed to stitch together a wound or tear.
The mother's and the baby's blood do not fully mix.
Passing through the birth canal moulds the baby's skull.
To enlarge the vagina the doctor performs a surgical cut.
Babies can feed themselves with a bottle at six months.
Heartburn can be controlled by drinking a glass of milk.
Being relaxed is one advantage of having a birth at home.
Most physical discomforts in pregnancy are not a big deal.
Twins are expected to be born before reaching full term.
Contractions can be eased by having a warm bath.
An epidural needle is punctured into the lower spine.
Some neonates are assisted by an oxygen tube in the nose.
Water retention can add to the amount of weight gain.
Pelvic floor exercises can successfully restore muscle tone.
Stimulating labour in postmature babies prevents harm.
Having a miscarriage may cause a couple a lot of grief.
A baby's head and ears should be kept above the water line.
Smoking may adversely affect an infant's size and height.
The nurse lays the newborn baby on the mother's lap.
There are many unusual foods that mothers will crave.
Some newborn babies are marked with red bumps and spots.
The method for folding a nappy varies with size and shape.
Many women choose to work and fulfill their maternal role.
A long first stage of labour can make the delivery hard.
During the later stages of gestation many women will bloat.
In hospital deliveries drugs are available for patient care.
Any unusual symptoms should be noted on the medical file.
The umbilical cord is designed to maintain blood flow.
Many mothers return to work and leave the baby in creche.
The feeling of nausea can be reduced by regular snacks.
Tracking growth of low weight babies is the doctor's task.
Sometimes the feeling of morning sickness can be very mild.
Painful labour is often due to tension arising from fear.
Some women rest until the baby is born because of risks.

Pregnancy-related, long sentences

Drugs that enter the woman's bloodstream pass through the placenta into foetal circulation.
Constipation during pregnancy is usually remedied without medical intervention.
Thrombosis in the legs is a problem for some mothers than can be reduced by walking regularly.
The delivery of a baby presenting buttocks first rather than head first can be complex and prolonged.
The sudden conception of a child for which the father is unprepared may cause an emotional disturbance.
The use of ultrasound machines in the last decade has been a great advancement.
A postnatal checkup to assess mother and baby is recommended in the first eight-week period.
Severe bleeding in third trimester of pregnancy suggests that a delivery may be necessary.
Dark stretch marks found on the stomach and other parts of the body are unlikely to vanish totally.
Mothers who participate in early discharge programs receive home visits from midwife services.
To protect the embryo women with inadequate diets should take vitamin and mineral supplements.
Postnatal care can last about half a year depending on the availability of local resources.
When the uterus is not working correctly an oxytocin drip is used to have the labour accelerated.
Some women have an uneventful pregnancy characterised by a symptomless progression.

Appendix D cont'd

Some pregnancy women often experience lassitude and tiredness as the birth-date approaches.
When the baby's head presses against the cervix, the labour speeds up because the contractions intensify.
The routine medical checkup for having a child involves obstetric techniques that are invasive.
Breastfeeding provides a supply of protein to the infant, but may cause the mother severe tenderness.
Organs grown in the uterus during pregnancy provide the embryo with its nourishment.
Drugs that enter the woman's bloodstream pass through the placenta into foetal circulation.
When a neonate's head diameter is larger than the mother's pelvis it may not descend properly.
To accommodate the rapid growth of the foetus the mother's body undergoes substantial adjustment.
Mothers with no history of childbirth are advised to have a hospital delivery as a precaution.
After ovulation the egg can be fertilized in the fallopian tube triggering foetal development.
Monitoring the embryo is required when the egg implants into a site that is abnormal.
Large quantities of hormones released into the mother's bloodstream encourage her body's adaptation.
In the second trimester, an enlarging uterus carrying a growing foetus becomes very noticeable.
To avoid fears about birthing, inexperienced mothers are encouraged to attend ante-natal education.
Performing an ultrasonic scan in late first trimester to observe fetal growth is very popular.
A number of serious infections associated with pregnancy can be treated with antibiotics.
Contractions continue after birth to allow the placenta mass to separate from its lining automatically.
Lower backache starting in third trimester results from relaxation of back muscles and ligaments.
For any vaginal bleeding during pregnancy caused by high hormone levels seek medical attention.
A vaginal discharge signals the onset of an infection that should be checked during the hospital's daily procedure.
There is a small chance that the infant's growth will be damaged by a very high surrounding temperature.
Medical conditions present in the mother are monitored to gauge potential birth difficulties.
The antenatal clinics provided by hospitals to ensure healthy fetal growth are known to be effective.
Implantation of the placenta near the cervix may cause some later complications.
A distressed baby experiencing a lengthy labour may not be delivered naturally.
Some gynaceologists consider that the use of breathing and relaxation techniques during birth is essential.

Appendix E

Table E1. Lists of target words in recognition test

	Pregnancy-related words	Neutral words
List A	forceps	beetles
	membrane	recourse
	lactating	magenta
	injection	rationale
	parent	garland
	premature	shortages
	stirrups	ringlets
	sucking	collapse
	breech	climbs
	cramps	pledge
List B	deformed	mayhem
	reproduce	molecule
	weaning	battlefield
	abdomen	remedies
	induce	exploit
	expectant	harvester
	bonding	clawing
	offspring	errand
	womb	hare
	kicks	tusks