Cognition in pregnancy: perceptions and performance

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Background

It is well established that if pregnant women are asked whether they believe their pregnancy has affected their cognitive abilities, many will report a decline (e.g. Casey, Huntsdale, Angus, & Janes, 1999; Crawley, Dennison, & Carter, 2003; McDowall & Moriarty, 2000; Sharp, Brindle, Brown, & Turner, 1993). While there are a number of plausible reasons why pregnancy might result in subtle changes in cognitive performance (including hormonal changes, emotional and mood changes, and an increase in self-absorption and preoccupation with the role changes accompanying pregnancy), the strength of pregnant women’s perceptions of worsening cognition does not appear to be warranted by the objective evidence from laboratory studies of their cognitive performance. There are some reports of a mild decline in specific cognitive functions such as incidental recall of words (Sharp et al., 1993), implicit memory (Brindle, Brown, Brown, Griffith, & Turner, 1991), verbal memory (Buckwalter, Buckwalter, Bluestein, & Stanczyk, 2001; Keenan, Yaldoo, Stress, Fuerst, & Ginsburg, 1998); retrieval from semantic memory (de Groot, Hornstra, Roozendaal, & Jolles, 2003), and selective attention (de Groot, Adam, & Hornstra, 2003). However, the evidence is not consistent (e.g. Casey et al., 1999 failed to replicate the effect on implicit memory; and McDowall & Moriarty, 2000, failed to replicate effects found by Brindle et al., 1991), and some studies have failed to find any effects at all (Casey et al., 1999; Casey, 2000; Christensen, Poyser, Pollitt, & Cubis, 1999; Crawley et al., 2003; McDowall & Moriarty, 2000).

The aim of this research was to investigate two possible reasons for the discrepancy between subjective and objective measures of pregnancy-related cognitive changes. The first possibility is that there are some real changes but these are mild and usually only noticeable in cognitively complex everyday situations. The perceived changes reported by pregnant women are small rather than dramatic (e.g. McDowall & Moriarty, 2000), and even when pregnancy-related deficits are detected using objective tests, the effects are small (e.g. Casey et al., 1999). It is therefore possible
that in the laboratory, when women know they are being tested, they can focus all
their cognitive resources on the task and so overcome any mild decline that they
notice in their everyday lives. The second possibility is that there are no real changes
and the perceived difficulties arise from expectations based on a societal myth or
stereotype. Expectations based on a negative stereotype appear to influence the
reporting of cognitive difficulties in the premenstrual phase of the menstrual cycle
(Marvan & Escobedo, 1999; Nicolson, 1995; Ussher, 1992). If the stereotype that
characterises women as victims of their hormones influences women’s beliefs about
their cognitive abilities during their menstrual cycle, it might also influence their
beliefs about other life events related to reproduction, including pregnancy.

These two explanations are not necessarily mutually exclusive. It is possible that
subtle changes in actual cognition and cultural expectations might both contribute to
the reporting of cognitive deterioration during pregnancy in the same way that both
actual changes and expectations appear to interact in the reporting of premenstrual
symptoms (e.g. Klebanov & Jemmott, 1992).

Objectives

The main aim of this project was to examine possible reasons for the discrepancy
between pregnant women’s perception of worsening cognitive abilities during
pregnancy and the objective evidence from studies that have assessed their
performance using objective tests of cognition in the laboratory. Three studies were
undertaken to explore two possible explanations.

The objective of the first two studies was to explore the possibility that the effects of
pregnancy are mild enough to be noticeable only in cognitively complex everyday
situations and not in the simpler, contrived tasks typically used to measure cognition
in the laboratory. In Study 1 the performance of 50 first-time pregnant women (25 in
their 2nd trimester and 25 in their 3rd trimester) and 25 non-pregnant, childless women
was compared on a range of cognitive tests. The tests were chosen because they
have been shown to be sensitive to mild cognitive decline and because they use
familiar, everyday materials. Thirteen tasks from four published tests providing a wide
coverage of memory and attention functions were used to compare the three groups
of women. In Study 2, the performance of 13 first-time pregnant women and 17 non-pregnant childless women was compared using two driving simulation tasks. Driving is one of the most cognitively complex everyday activities, and some pregnant women have reported changes in their driving behaviour when pregnant (e.g. Crawley, 2002). If there are real effects of pregnancy on cognition, the cognitively demanding nature of the driving tasks maximises the possibility of revealing such effects. In both studies, the perceptions of the pregnant and non-pregnant participants regarding recent cognitive change were measured using a series of self-rating scales.

The main objective of Study 3 was to ask whether there is a stereotype of pregnancy being accompanied by a decline in cognitive abilities that might influence pregnant women’s perceptions of cognitive change. The existence of such a stereotype in the general public was investigated by asking two groups of men and women, those in frequent, daily contact with pregnant women (pregnant women themselves and their partners), and those with infrequent contact (childless women and men), to rate the likelihood of pregnancy-related cognitive changes. Ninety-nine pregnant women took part, 55 male partners of pregnant women, 100 childless women and 100 childless men. If a stereotype exists, it might lead women to be more aware of their cognitive slips (the kind everyone makes) and attribute them to their pregnancy. This might either wholly explain the self ratings or, if there are some real mild and specific changes in cognition, it might magnify these changes so they are perceived to be more marked than they actually are.

A subsidiary objective of Study 3 was to examine the influence of expectations on the reporting of pregnancy-related changes by pregnant women. The pregnant women were asked to complete the ratings in two forms: once in relation to pregnant women in general, and once in relation to their own, personal experience. A positive correlation between the ratings for women in general and ratings for the pregnant women specifically would be consistent with an influence of expectations on the perception of personal changes.

The objectives of the three studies were met. Details are provided in the Methods and Results sections below. The only deviation from the original design of the studies was that in Study 2, the plan to divide the group of pregnant women into those in their 2nd trimester and those in their 3rd trimester was not possible. Recruiting difficulties meant that not enough women were tested to allow the more detailed
examination of pregnancy by trimester. The comparison across trimesters was possible in Study 1 and showed little evidence for a difference so the lack of a comparison by trimester in Study 2 is not a major problem.

Methods

Self-ratings of cognitive change
In all three studies, participants completed 21 self-rating items relating to possible cognitive and emotional changes they might have experienced recently, either in comparison with their pre-pregnant selves (in the case of the pregnant participants) or in comparison with one year ago (in the case of the non-pregnant participants). All were rated on a 7-point scale (where 1 = much more able, 7 = much less able). The 15 items relating to changes in cognitive abilities were chosen to reflect a range of cognitive functions suggested as potentially affected by pregnancy in the published literature. The cognitive items were categorised and analysed as three composites of five items each: memory (ability to find the right word when speaking; memory/forgetfulness; ability to remember names; ability to remember appointments, important dates, etc.; ability to remember what has been read), attention (absentmindedness; ability to concentrate; preoccupation; ability to think clearly; ability to divide attention), and applied cognitive abilities (ability to make decisions; effectiveness at work; ability to drive a car; organisational ability; ability to learn). Six filler items related to other possible pregnancy-related changes (e.g. tiredness, emotional changes). Participants were given the opportunity to make additional comments beside each item and, at the end, to note examples from personal experience. They were also asked to indicate which, if any, of a list of given factors (e.g. hormonal changes, tiredness) they thought might be responsible for any reported changes in cognition.

In Study 2 participants completed an additional question asking whether they were aware of any changes in their driving habits either since becoming pregnant, or (in the case of non-pregnant women) compared with one year ago. If they answered yes, they were asked to check specific examples on a list of possible changes (e.g. driving more quickly, driving less frequently, forgetting where their car was left in a large car park, intending to drive to A and finding themselves on the road to B).
Ratings of cognitive change in pregnant women in general
In Study 3 a version of the self-rating scale described above was used in which the items to be rated referred to changes that might be experienced by pregnant women in general.

Tests of cognition
Thirteen cognitive tasks from four published tests were used in Study 1. The tasks (with the cognitive functions measured in parentheses) were as follows:

- The Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1991): story recall task (explicit retrospective memory).
- Speed and Capacity of Language-Processing Test (SCOLP, Baddeley, Emslie, & Nimmo-Smith, 1992): speed of comprehension task (speed and efficiency of language comprehension). The Spot-the-Word task from the SCOLP was used to match the pregnant and non-pregnant participants for verbal intelligence.
- Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996): zoo map task (planning ability) and modified six elements task (planning, organisation and prospective memory).
- Test of Everyday Attention (TEA: Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994): map search task (visual selective attention), elevator counting task (sustained attention), elevator counting task with distraction (auditory-verbal working memory and auditory selective attention), visual elevator task (attentional switching), elevator counting task with reversal (manipulation of information in auditory-verbal working memory and auditory selective attention), telephone search task (visual selective attention), telephone search task while counting (sustained and divided attention), lottery task (sustained attention).

Driving simulation tasks
The driving simulator consisted of a mock driving seat, dashboard, steering wheel, accelerator and brake pedals linked to a simulated road environment and data acquisition system. Three LCD projectors displayed the driving simulation on to three 2.29m x 2.50m screens creating a total viewing angle of 120 degrees. Data were acquired from signals on the primary controls of the driving rig via a data acquisition
card and an interface card, and were stored in a real-time and an event log. There were two tasks; a brake task and a junction task:

- **Brake task**: participants completed 10 trials in which they drove along a straight stretch of road (on a hill) with one car visible in front. The task was to brake as soon as the brake lights of the car in front came on. Measures taken were thinking time (from the brake light coming on to the time the participant's foot came off the accelerator), movement time (from thinking time until the first detectable pressure on the brake pedal), 100N response time (from the first detectable brake pressure until 100 Newtons has been applied to the brake), and total brake time (thinking time, plus movement time, plus 100N response time).

- **Junction task**: participants turned right from a stationary position at a T-junction into a main road in which the direction of traffic flow and gap size were manipulated. There were two trials in which there was no other traffic on the road (practice trials), and two trials in each of three traffic conditions (traffic from the right, traffic from the left, and traffic from both directions). In the three traffic conditions, the scenario began with a group of eight cars driving past the stationary participant, followed by a gap, a group of three cars, a gap, and so on. The gap sizes became progressively larger. The measures taken were decision time, manoeuvre time, gap size accepted, time to collision, and the number of collisions with other vehicles or street furniture. The decision time is the time from the beginning of the scenario until the gap is accepted and the participant presses the accelerator to move forward. Manoeuvre time is the time at which the trial ends (when a fixed point on the main road is passed) minus the decision time. Gap size is the size of the gap in the traffic flow that the participant turned into. The time to collision is the time it would take two vehicles to collide if they continued on their route at the current speed, without braking or taking evasive action. For the third scenario where traffic flowed in both directions, time to collision was calculated for both the vehicle coming from the left and the vehicle coming from the right. The shorter of these two times was used in the analysis.

**Results**

**Perception of pregnancy-related changes in cognition: Self-ratings**

In Study 1, ANOVAs showed that the composite mean self-ratings for memory, for attention and for applied cognitive abilities differed significantly between the three groups of women. For all three composites, post hoc Tukey tests revealed that the
non-pregnant women gave lower ratings than either the 2\textsuperscript{nd} or 3\textsuperscript{rd} trimester women. Similarly, in Study 2, t-test comparisons showed that the pregnant women rated themselves as worse than the non-pregnant women on all three composite measures. The self-ratings provided by the pregnant women in Study 3 showed a similar perception of mild decline in memory, attention and applied cognitive abilities. Personal examples of changes noted include “since becoming pregnant, when talking I sometimes find I can’t remember the most simple words” and “I find myself in a different place to where I intended to be”.

The self-ratings show that the pregnant women perceive that their cognitive abilities have changed for the worse since they became pregnant, as predicted.

**Pregnancy-related differences in cognitive performance**

**Study 1: Cognitive tasks**

The scores for 71\% percent of participants reached ceiling for the modified six elements task from BADS, and the majority of participants (91\%) performed at ceiling level on the elevator counting task from the TEA, so no comparisons were conducted for these measures. For the remaining measures, the performance of the three groups of women was compared using a series of one-way ANOVAs. Bonferroni adjustments were made to control for the possibility of inflated Type I errors due to multiple comparisons (with an adjusted significance level of $p \leq .0038$). Group differences were found for two measures only: the scaled score of the speed of comprehension task from the SCOLP, and the scaled timing score of the visual elevator task from the TEA. Post hoc Tukey tests showed that the non-pregnant women completed more items in the speed of comprehension task than either the 2\textsuperscript{nd} or 3\textsuperscript{rd} trimester pregnant women, and that women in their 3\textsuperscript{rd} trimester were significantly slower at attentional switching in the visual elevator task than either women in their 2\textsuperscript{nd} trimester or non-pregnant women.

**Study 2: Driving simulation tasks**

In the brake task, independent t-test comparisons showed no difference between the pregnant and non-pregnant women on any of the four measures. Similarly, in the junction task there was no difference between the pregnant and non-pregnant women on any of the four measures. Mixed 2x3 ANOVAs comparing each of the junction task measures for the pregnant and non-pregnant women in each of the three conditions (traffic from the right, from the left, and from both directions) showed
only a significant effect of traffic direction reflecting the difficulty of the task in the different traffic flow conditions.

The comparison between the pregnant and non-pregnant women on the performance measures from the four published cognitive tests and the measures from the two driving simulation tasks showed very little effect of pregnancy. There was no effect on any of the measures from the driving simulation tasks in Study 2 and, of the 15 measures compared from the cognitive tests in Study 1 there were only two differences, one on a speed of language processing measure and the other on a speed of attentional switching measure. The evidence from the comparison of test performance in Study 1 and driving simulation task performance in Study 2 would not seem to warrant the perception of cognitive decline revealed in all three studies by the pregnant women’s self-ratings.

**Perceived changes in cognition: Ratings of pregnant women in general**

In Study 3 the mean ratings for the three composite ratings (memory, attention and applied cognitive abilities) from all four groups (pregnant women, their partners, childless women and childless men) were all above 4 but below 5 indicating a belief amongst all groups that cognitive abilities decline slightly during pregnancy. Analysis of the composite ratings of attention and applied cognitive abilities ratings using 2x2 ANOVAs with immediate experience of pregnancy and gender as factors revealed no significant effects of either factor, and no interactions. However, a 2x2 ANOVA of the memory composite ratings showed significant effects of both factors. Those with immediate experience rated memory as worse than those without, and women as a group rated pregnant women’s memory as worse than men as a group.

**Perceived reasons for cognitive change:** Chi-square comparisons showed that the percentage who did not believe cognitive changes were generally experienced in pregnancy differed significantly across the four groups in Study 3. For example, only 8% of pregnant women doubted cognitive change was experienced during pregnancy, compared to over a quarter of the childless women. A higher percentage of those with immediate experience of pregnancy believed tiredness was a cause of cognitive change, and a higher percentage of those without immediate experience believed that nutritional or lifestyle changes were responsible. There were no differences in the percentage of participants choosing hormonal changes (a high
percentage in all groups) or preoccupation with pregnancy/motherhood as potential causes.

**Correlation between self-ratings and ratings of pregnant women in general:** The pregnant women’s mean composite self-ratings for memory, attention, and applied cognitive abilities were very similar to the ratings they gave for pregnant women in general with significant positive correlations between self-ratings and ratings for women in general in each case.

The results of Study 3 suggest that there is a pervasive stereotype of mild pregnancy-related cognitive decline. It is not only women and men who are currently living with their own or their partner’s pregnancy who rate pregnant women as slightly worse in memory, attention and applied cognitive abilities, it is also women and men of comparable age who have never had close contact with pregnant women. It is noteworthy, however, that the perception is that the changes are not substantial. For all groups, the mean rating was only just on the negative side of ‘same as usual’. The positive correlation between pregnant women’s ratings for women in general and their self-ratings suggests there may be an influence of expectations on the reporting of pregnancy-related changes.

**Conclusion**

The results of these three studies suggest that pregnant women’s reports of cognitive decline during pregnancy exceed any actual performance decrements. While there was some evidence from Study 1 that pregnant women performed worse in tasks measuring speed of language processing (in the 2nd and 3rd trimesters) and attentional switching (in the 3rd trimester only), there was no evidence for worse performance in the cognitively complex driving simulation tasks. Thus, the evidence from this, and other studies, is that there is little change in performance during pregnancy and no consistency in the specific aspects of cognition affected. It is possible therefore that the effect of pregnancy on cognition is either entirely, or if one accepts that there are changes in some specific functions, primarily a metamemory effect. In other words, pregnancy’s major influence is on women’s beliefs about their cognitive ability rather than their cognitive abilities themselves. The ratings in Study 3 show that the belief that cognition is worse during pregnancy is widespread. This stereotype may influence pregnant women’s perceptions of their cognition by making
them more aware of everyday cognitive slips (the kind everyone makes) which they attribute to their pregnancy because of the cultural stereotype within which they are experienced.

Activities

The research has been presented at research seminars in the Department of Psychology, University of Sunderland (November 2005) and the Institute of Neuroscience, University of Newcastle-upon-Tyne (May, 2006). A presentation was made to about 35 staff of the obstetrics department (including midwives, midwife team leaders, matrons, consultant obstetricians, registrars, and SHOs) at Sunderland Royal Hospital (January 2006). Written summaries of the findings were sent to the ten midwife teams involved in recruiting participants, and to participants who requested them.

The following conference presentations have been made:


There was much media interest following the presentation at the British Psychological Society conference. Following interviews with newspaper journalists at the conference and a telephone interview with a journalist from the Press Association, a number of reports appeared in national newspapers (including The Times, The Independent, The Daily Telegraph, The Daily Express, and Irish Independent), regional newspapers (including Liverpool Daily Post, and the Yorkshire Post) and on websites (including British Nursing News Online, and the Mental Health Foundation) in April 2006. There was also a report of the research in the British Psychological Society’s publication The Psychologist (Volume 19, 350). In addition, interviews with Ros Crawley were included in the BBC TV programme ‘How to improve your memory’ (August 2006) and the Australian radio programme ‘All in the Mind’ (October 2006).
Outputs

One journal article has been prepared and will be submitted to Applied Cognitive Psychology by the end of November 2006:
Crawley, R.A., Grant, S.M., & Hinshaw, K. Cognitive changes in pregnancy: mild decline or societal stereotype?

Another journal article is in preparation and will be submitted to an obstetrics journal, probably the Journal of Psychosomatic Obstetrics and Gynecology.

The dataset has been accepted for deposit at the Data Archive and will be sent in December 2006.

Impacts

There has been substantial interest in the findings so far reported with much media coverage because of the challenge to the prevailing view that memory and attention abilities decline during pregnancy.

Future research priorities

While these findings suggest that the effect of pregnancy is primarily an effect on beliefs about cognition, there is some suggestion of specific effects on speed of language processing and speed of attentional switching. In relation to the finding that pregnant women were slower on the language processing task, it is interesting to note that the personal examples offered by pregnant women include examples of word finding difficulties and this deserves further attention. In addition, there is a need to explore further why there is no consistency in which particular cognitive function appears to be affected in this and other published studies.
References


