The Effects of Cortisol on Memory Recall

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Introduction

Glucocorticoids (GCs), produced by the stress-responsive hypothalamic-pituitary-adrenal axis, regulate the body’s stress response (Newcomer et al. 1999, Roozendaal 2002). Kuhlmann et al. (2005) demonstrated that glucocorticoids enhanced memory consolidation but impaired delayed memory retrieval of emotional words. Kuhlmann and Wolf (2005) performed the experiment in a more relaxed test setting. They concluded cortisol had no effect on memory retrieval of either emotional or neutral words. A review of 16 studies determined that the timing of the GC administration was a major determinant of the effects of cortisol on human memory (Het et al. 2005, Maheu et al. 2005). Further analysis on these experiments indicated that studies which administered cortisol in the morning found significant memory impairment, while studies conducted in the afternoon observed a small but significant memory enhancement (Het et al. 2005).

Endogenous or exogenous gonadal steroids may also influence the effects of cortisol on memory. Kuhlmann and Wolf (2005) tested the effects of cortisol on recall of women taking oral contraceptives versus those who were not on oral contraception. There were significant differences between the two groups.

The purpose of this study was to test the effects of cortisol on memory recall in females in the same menstrual phase (fOLLICULAR).

Methods and Materials

- Ten females in the follicular phase were tested.
- Baseline cortisol concentrations were measured by immunoassay of saliva samples. Each participant was presented with a list of 15 negative words and 15 words with a neutral connotation. Subjects studied the list for 15 minutes. Twenty four hours later, subjects were asked to recall as many words as possible. A follow up cortisol sample was taken.
- The subjects were tested one month later using the same list of words in a different order, after being exercised on a treadmill at 60% of their heart rate maximum for 15 minutes. Twenty four hours, after exercising, subjects were asked to recall as many words as possible, followed by the fifth and final saliva assay.
- Differences in cortisol concentration and recall were analyzed by paired repeated measures ANOVA with a post hoc test.

Results

Prior to Stressing

- The mean number of negative recalled words was 10.8 (± 3.05 SD) (Figure 1).
- The mean number of neutral recalled words was 12.1 (± 2.88 SD) (Figure 1).

After Stressing

- The mean number of negative recalled words was 12.1 (± 3.7 SD) (Figure 2).
- The mean number of neutral recalled words was 13.7 (± 1.83 SD) (Figure 2). On day 30, cortisol levels were taken prior to and following exercise. The mean cortisol concentration taken prior to exercising was 0.99 µg/dl. Levels taken immediately after exercising had a mean concentration of 0.96 µg/dl; there was no statistical difference between levels prior to and after exercising (Figure 3).

Conclusions

This study used recall as a way to detect the effects of cortisol on memory recall, however, cortisol was not administered. Previous studies (Kuhlmann et al. 2005), this study found differences in retrieval without changing cortisol levels.

In this study, subjects were naturally stressed by the way of exercise. Subjects exercised for 15 minutes at 60% heart rate max intensities was not high enough to change cortisol levels. Studies have shown that exercising at 70% heart rate max is effective to increase cortisol levels (Grace 2000). This study showed there were memory differences without an increase in endogenous or exogenous cortisol.

In previous studies there were differences between women who were taking contraceptives compared to women who were not (Kuhlmann and Wolf 2005). To eliminate this variable, all participants in this study were not on oral contraceptives. The differences in this study were not due to hormonal changes.

There were significant differences in word recall but they were not due to cortisol or gonadotrophins. In retrospect, the fact that cortisol was not increased allowed differences to be seen without cortisol. Future research on the nature of recall of negative words might use other variables besides cortisol.

Acknowledgements

I would like to thank all those who volunteered for this study, who donated their time and participation. I would like to thank the entire biology faculty, that by way of their discussion and written critiques, helped to improve the written quality of this research. And a special thank you to Randy Day for his knowledge, expertise and mentorship during this research.

References


Table 1. The comparison of p-values between Day 1 Negative vs. Neutral word recall, Day 31 Negative vs. Neutral word recall and Total word recall of Day 1 vs. Day 31.

<table>
<thead>
<tr>
<th></th>
<th>Day 1 Negative vs. Neutral Word Recall</th>
<th>Day 31 Negative vs. Neutral Word Recall</th>
<th>Total Word Recall Day 1 vs. Day 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-Value</td>
<td>p = 0.0174</td>
<td>p = 0.033</td>
<td>p = 0.122</td>
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Figure 1. The mean (± SD) number of words recalled from a list of 30 words, 24 hours after introduction to the list of words.

Figure 2. The mean (± SD) number of words recalled from a list of 30 words, 24 hours after introduction to the list of words.

Figure 3. Cortisol concentrations prior to and immediately following exercising for 15 minutes at 60% max.