Decreased Susceptibility to False Memories from Misinformation in Hormonal Contraception Users

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Abstract

Sex hormones are increasingly implicated in memory formation. Recent literature has documented a relationship between hormones and emotional memory, and sex differences, which are likely related to hormones, have long been demonstrated in a variety of mnemonic domains, including false memories. Hormonal contraception, which alters sex hormones, has been associated with a bias toward gist memory and away from detail memory in women who use it during an emotional memory task. Here, we investigated whether hormonal contraception was associated with changes in susceptibility to false memories, which may be related to the formation of gist memories. We tested false memory susceptibility using two well-validated false memory paradigms: the Deese-Roediger McDermott (DRM) task, and a story-based misinformation task. We found that hormonal contraceptive users were less susceptible to false memories compared to non-users in the misinformation task, and no differences were seen between groups on the DRM task. We hypothesize the differences in false memories from the misinformation task may be related to hormonal contraceptive users' memory bias away from details, toward gist memory.

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1. Introduction

Hormonal contraception (HC) use is highly prevalent in women across the world, most commonly to prevent pregnancy by suppressing ovulation. To do this, synthetic hormones -- most commonly, a synthetic estrogen analog called ethinyl estradiol, and a synthetic progesterone analog called a progestin -- facilitate the negative feedback loop of the hypothalamic-pituitary-gonadal (HPG) axis (Lobo & Stanczyk, 1994). As a result, the production of luteinizing hormone (LH) and follicle stimulating hormone (FSH) from the pituitary is significantly reduced, as is the gonadal production of estrogen, progesterone, and testosterone (Lobo & Stanczyk, 1994). Without these hormonal signals, ovulation is suppressed and pregnancy is prevented. However, the reduction in endogenous hormones and addition of synthetic hormone analogs is systemic rather than limited to the reproductive system, and unintended side effects on cognition and behavior have been associated with HC use.

Previous research indicates that sex steroid hormones are critical for modulating certain types of memory, especially under conditions of hypothalamic-pituitary-adrenal (HPA)-related stress (Kudielka & Kirschbaum, 2005). Therefore, since hormonal contraception profoundly alters HPG activity and HPA reactivity (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999; Nielsen, Segal, Worden, Markey, & Cahill, 2013; Bentz et al., 2013; Nielsen, Ahmed, & Cahill, *in press)*, and the HPG and HPA axes have a bi-directional relationship (Turner, Keating, & Tilbrook, 2012), it is likely that under conditions of arousal and/or stress, use of hormonal contraceptives alters learning and memory in these women.

Recent research with hormonal contraceptive users supports these predictions. For example, studies involving exogenous cortisol administration found that verbal retrieval (Kuhlman & Wolf, 2005) and fear learning (Merz et al., 2012) were modified in hormonal contraceptive users compared to naturally cycling women and men. Other work has utilized classical conditioning paradigms (Beck et al., 2008; Holloway, Beck, and Servatius, 2011; Merz et al., 2013; Merz, Stark, Vaitl, Tabbert, and Wolf, 2013) and long-term memory paradigms with an emotional story (Nielsen, Ertman, Lakhani, and Cahill, 2011; Nielsen, Ahmed, and Cahill, *in press*) and emotional images (Nielsen et al., 2013) to demonstrate that women on hormonal contraception exhibit altered learning and memory patterns under arousal and stress.

These learning and memory paradigms, however, have focused primarily on learned responses and correctly recalled information. To date, no study has examined whether hormonal contraception use affects false memory rates in women. Although there is a robust literature on false memories (for reviews see Loftus, 2005; Gallo, 2010), there is limited work exploring any potential relationship between sex hormones and false memory. However, a recent study examined whether biological sex influenced false recall in the Deese/Roediger-McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm (Dewhurst, Anderson, and Knott, 2012). Results indicated that compared to men, women falsely recalled more negative lures; this sex differences was not observed for recall of neutral words. One potential explanation for this difference was that women were encoding the “emotional gist” of the words more so than men, and as a result, women falsely recalled more critical lures (Dewhurst, Anderson, and Knott, 2012). However, other work with emotional memory for “gist” suggests that men may encode and recall emotional gist better than women (Cahill and van Stegeren, 2003; Nielsen, Ahmed, and Cahill, 2013).

Thus, the sex differences observed in the study by Dewhurst and colleagues (2012) may not simply be the result of women encoding the "gist" to a greater degree than men. It is also quite plausible that sex steroid hormone levels may have modulated the false memory effects in women, For example, higher levels of estradiol in women are associated with improved performance on a working memory task in naturally cycling women (Hampson and Morley, 2013). Given that the DRM is a working memory task, levels of estradiol may also modulate performance in female participants. Since Dewhurst and colleagues (2012) did not account for menstrual cycle phase or HC use, it is unclear at this point what the specific contributions of sex hormone levels might be to a false memory paradigm.

Importantly, as described previously, the sex and stress hormone systems interact with one another to influence memory. Zoladz et al. (2014) showed that a pre-encoding stressor that triggers cortisol release influences DRM performance differently in men and women. Both showed fewer false memories in the stress condition, and women recalled more true memories in the stress condition as well. This latter finding was not observed in male participants.

Since veridical memory seems to be influenced by sex and stress hormone levels, and hormonal contraception use clearly affects learning and memory in women, we hypothesized that false memory may also be susceptible to hormonal influences at encoding and retrieval. Thus, to address this hypothesis, we utilized misinformation and DRM word list memory distortion paradigms. The present study included naturally cycling women and women on hormonal contraception; these women participated in the DRM and the misinformation memory distortion paradigms. Hormonal contraceptive users have reduced levels of endogenous estradiol (Nielsen, Ahmed, and Cahill, in press) and exhibit better recall of emotional gist (Nielsen et al., 2011) compared to naturally cycling women. From this past research we formed two research questions and possible hypotheses:

1. Misinformation paradigm: Predicting an outcome on the misinformation paradigm is complicated by the fact that the task includes two separate encoding phases: presentation of the original event in photographs, and later presentation of the misinformation in a text narrative. If the HC women's bias toward gist (as seen in Nielsen et al., 2011) influences memory encoding differently compared to NC women, we may expect to see more false memories in HC women as they incorporate the misinformation into the original event to form a single "gist" memory for the narrative. However, this bias toward gist could also appear as a deficit for details, diminishing the encoding of the misinformation details, leading to an overall reduction in false memories.

2. DRM paradigm: If, as in Nielsen et al. (2011), HC users have a gist bias and detail deficit, then it may be tempting to think that HC users would be more prone in a DRM task to attend to the semantic meaning of the words rather than the fine detail of the actual words. However, because the DRM task is relatively less emotionally arousing than the emotional condition in Nielsen et al. (2011; a little boy hit by a car), it is possible that we might find no differences between HC and NC groups, in the same way Nielsen et al. (2011) found no gist versus detail bias between HC and NC groups in their neutral condition.

2. Material and Methods

2.1 Participants

Ninety-five women of normal memory ability participated in the study. Two women were eliminated from the analysis because they reported being pregnant or nursing at the time of participation, and a further one woman was eliminated for not answering the oral contraception question. Women over the age of 40 were also excluded. Of the 92 participants included in the analysis, the mean age was 20.7 (*SD* = 3.53; range 18 to 38 years). Ethnicity distribution was 50.0% Asian, 20.7% Latino/Hispanic, 15.2% Caucasian, 6.5% Middle Eastern, 4.3% Black, and 3.3% other ethnicities. Most participants (87) were undergraduates recruited through UC Irvine's subject pool and compensated with course credit. Five non-student women were recruited using Amazon Mechanical Turk, and compensated with $40 each. These 5 non-students had also served as control participants in Patihis et al. (2013), but apart from those the present study is a new sample of participants.

2.2 Materials and Procedure

We used the same misinformation and DRM materials as had been used in Patihis et al. (2013). Most subjects (*n* = 64; all students) came into the laboratory to participate in Session 1 and 2, with a researcher present in lab. Others (*n* = 28; 23 students, 5 non-students) participated at their home on their own computer, with the researcher connected to them via Skype video-chat or phone for the entirety of both Session 1 and 2. Researchers advised the participants before the study commenced on how to avoid distractions and interruptions. Inclusion criteria required that participants were under female and under the age of 41. Participants were excluded if they were pregnant or nursing at the time of the study (*n* = 2). An additional participant was excluded for failing to answer whether she was using hormonal contraceptives at the time of the study. The sample size was powered to detect moderate to large effects at 80% power, and our stopping rule for data collection ensured that data was not analyzed before data collection ceased.

In Session 1, participants answered questions regarding their hormonal contraceptive use and menstrual cycle, demographic questions, and some other survey questions. Seven days later, in Session 2, they participated in a misinformation task, and a DRM word list task, with other survey questions as filler tasks. Some of those survey questions are not analyzed here. Participants were told that the study was about personality, individuality, and slideshows. In order to hide the true purpose of the study no mention of memory distortion was made.

2.2.1 Misinformation. The misinformation-effect paradigm materials used were those that had worked well in previous research (Okado & Stark, 2005; Patihis et al., 2013). These materials consist of two slideshows with 50 photographs each, depicting stories of two nonviolent crimes. The first photographic slideshow depicted the stealing of a purse, and the second depicted a man breaking into a car and stealing items. Each photograph was presented on screen for 3500ms. About 40 minutes later, participants were shown two text narratives of these events but they contained six instances of misleading information. Participants randomly assigned to Group A got a different set of six misleading items to Group B, such that each group served as the experimental group on some items and the control group on other items. Each narrative consisted of 50 sentences that were shown onscreen for 5500ms. About 60 minutes after the original photographs were shown, there was a recognition memory test followed by a source-of-memory test.

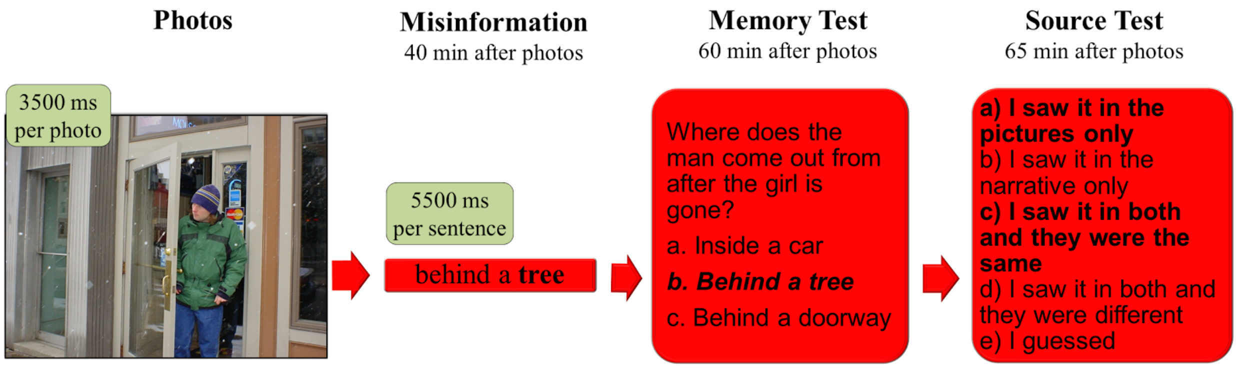

Figure 1. Sample misinformation paradigm materials illustrating an event photograph for which participants later received misleading post-event information. The part ("behind a tree") of a longer sentence containing the misinformation is shown. In this case, choosing (b) at the memory test would be counted as an overall false memory. If the participant also chose (a) or (c) in the source test, this would be considered a source-confirmed false memory.

2.2.2 DRM. The DRM word list materials were adapted from other successful paradigms (e.g., Roediger, Watson, McDermott, Gallo, 2001), in which 20 separate fifteen-word lists were presented. As shown in Figure 1, each word was shown on screen for 1500 ms. After the word lists had finished, a short filler task was completed (~3 min) and then their recognition of those words were tested. Participants indicated whether each word at test was either "old" or "new." As in Patihis et al. (2013), the lists used in this study had the following critical lures: Lamp, Trash, Slow, Wish, Foot, Window, Soft, Chair, River, Stove, Anger, Justice, City, Rough, Mountain, Music, Thief, Doctor, Cold, and Needle.

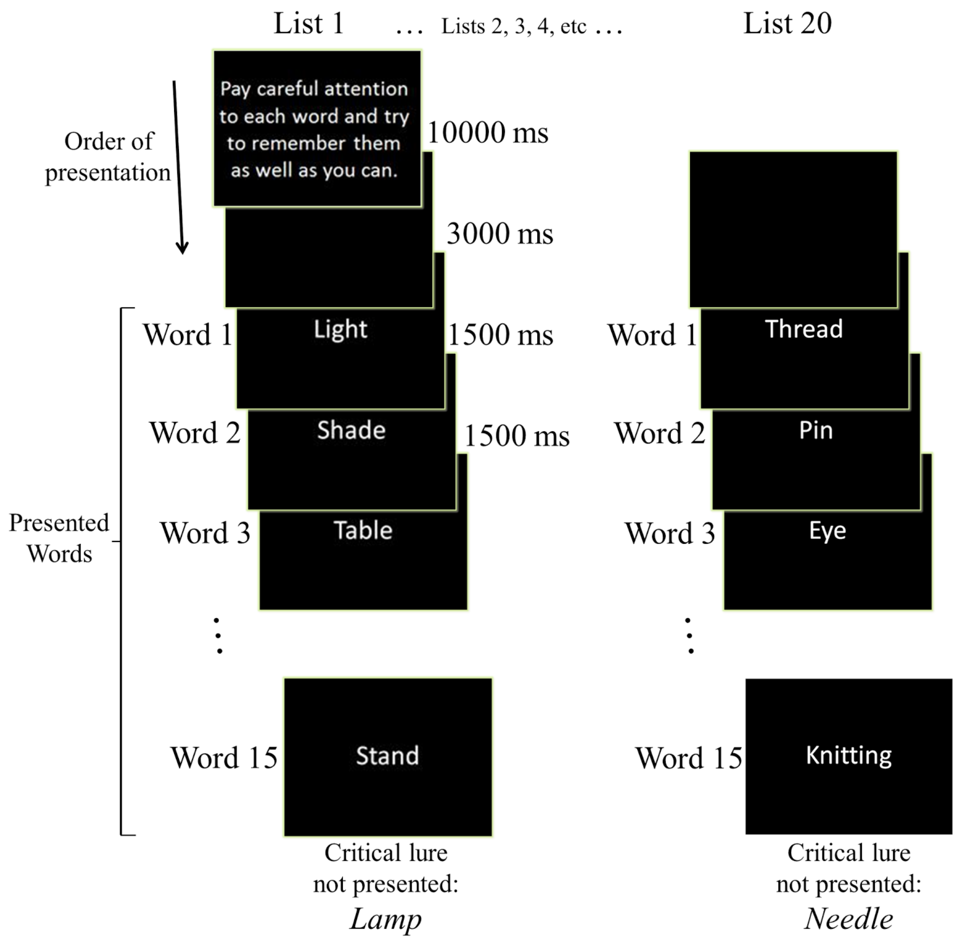

Figure 2. DRM word list paradigm sample materials for the presentation stage. Twenty lists were shown, each 15 words long. A few minutes afterwards the subjects completed a "new" "old" recognition test (not shown above).

2.2.3 Contraceptive Use and Cycle. Participants were assigned to groups on the basis of their response to the question, "Are you currently taking hormonal contraception?" during Session 1. Naturally-cycling (NC) women were those who responded "no" to that question, and hormonal contraception (HC) users were those who responded "yes." The brand of contraceptive and length of use was also recorded. Women using any form of hormonal contraceptive, including the ethinyl estradiol/etonogestrel-releasing vaginal ring ($N = 2$), were included in the analysis. Three participants reported using hormonal contraceptives but could not recall the name of the brand used.

NC women were further divided into subgroups on the basis of their self-reported menstrual cycle phase: women whose period began 7-12 days before Session 2 were assigned to the “follicular” group and those whose period began 17-28 days earlier were assigned to the “luteal” group. Women whose period began 13-16 days earlier were assigned to the “possibly ovulating” group and not included in any analysis.

3. Results

3.1 Memory Distortion Overall Rates

3.1.1 Misinformation. In keeping with past research (Patihis et al., 2013), overall false memory in the misinformation task is the number of misinformation-consistent responses at the recognition test. Source-confirmed false memory is the number of those false reports that are confirmed in the source test to have been seen in the original photographic slideshow. In the current sample of 92 women the mean overall false memory was 1.74 (SD = 1.37) and the mean source-confirmed false memory was .93 (SD = .85). When comparing participants who got misinformation on certain items, to those who received no misinformation on those items, we found a significant misinformation effect on overall false memory (Group A misinformation items $t(90) = 2.98$, $p = .004$; Group B items $t(90) = 2.36$, $p = .020$) and partially for source-confirmed false memory (Group A misinformation items $t(64.4) = 2.59$, $p = .004$; Group B items $t(82.4) = 1.29$, $p = .199$).

3.1.2 DRM. Of the 92 women in the analysis, the mean percentage of critical lures (words related to the presented words, but not actually presented themselves) falsely endorsed was 62.3% (*SD* = 21.5%). The mean percentage of presented words correctly endorsed was 64.1% (*SD* = 16.0%). The mean percentage of non-presented words that were not critical lures was 20.7% (*SD* = 19.2%).

3.2 Oral Contraceptive Use and Memory

3.2.1 Misinformation paradigm.

3.2.1.1 Overall false memory. When performance was compared between groups on the misinformation task, HC users reported significantly fewer overall false memories, $t(90) = 2.33$, $p = 0.0219$ (Figure 1). On average, HC users recalled 1.14 (*SD* = 1.24) false memories compared to $M = 1.91$ (*SD* = 1.36) in NC women. The size of the effect was moderate, $\eta^2 = 0.06$, Cohen's $d = 0.59$. However, the sizes of the two groups compared appeared unequal with *N*s = 71 and 21 for naturally-cycling (NC) and hormonal contraceptive (HC) groups, respectively. Thus, equality of variance was tested by the O'Brien, Brown-Forsythe, Levene, and Bartlett tests. All yielded *p*s > 0.1, indicating that the variance in each group did not differ significantly from the other. Welch's test was also performed, despite evidence that the groups had equal variance, and the effect remained significant, $t(90) = 2.46$, $p = 0.019$. Excluding women who self-reported irregular cycles (19 NC, 1 HC) increased the size of the effect, Student's $t(70) = 2.51$, $p = 0.0142$, $\eta^2 = 0.08$, $d = 0.69$.

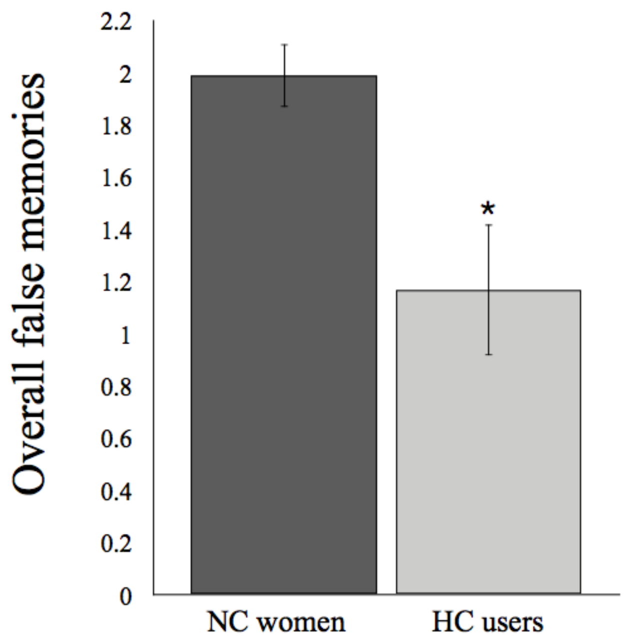

Figure 3. In a misinformation experiment, hormonal contraceptive users endorsed significantly fewer overall false memories compared to naturally-cycling women. Error bars represent standard errors of the mean.

3.2.1.2 Source-confirmed false memory. As illustrated in Figure 4, rates of endorsing source-confirmed false memory were also compared between groups. Again, inequality of variance was tested and this time found to be significant by Bartlett's test, $p < .01$, with the Levene, Brown-Forsythe, or O'Brien tests giving marginal *p*-values, (.07, .08, and .08, respectively). Therefore, we did not assume equal variance and used Welch's test, and the two did differ significantly, however the significance was borderline, $t(90) = 2.99$, $p = 0.0499$, $\eta^2 = 0.02$, $d = 0.42$. Excluding women with self-reported irregular cycles resulted in a marginal *p*-value: Welch's $t(70) = 1.73$, $p = 0.088$, $\eta^2 = 0.02$, $d = 0.40$. Due to the marginal results, both in the equality of variance and the second Welch test, caution is warranted in interpreting these results.

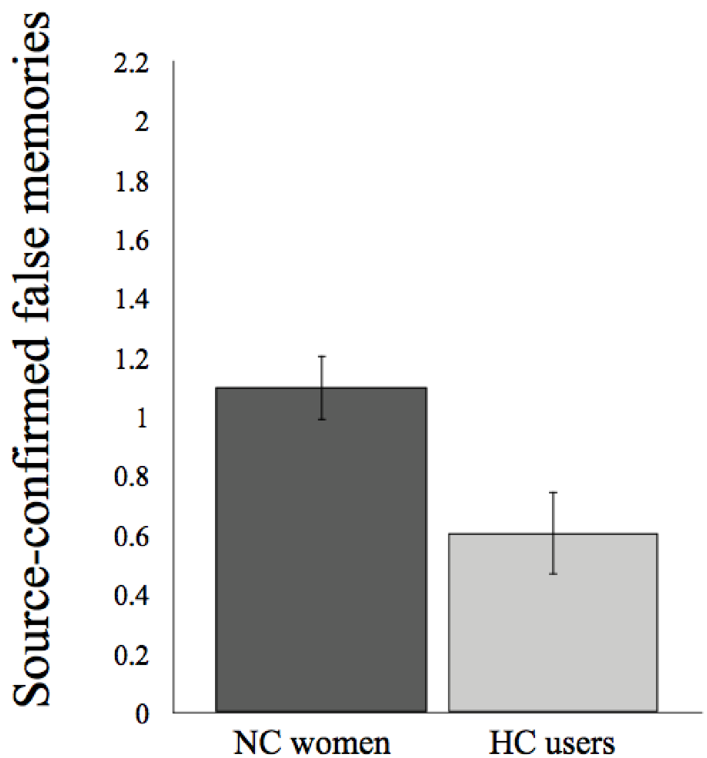

Figure 4. Mean source-confirmed false memories in oral contraceptive users and naturally cycling women. The direction of the relationship was the same as in the overall false memory comparison, with HC women endorsing fewer source-confirmed false memories, but the difference was only marginally significant. Error bars represent standard errors.

3.2.1.3 Accuracy When No Misinformation. On accuracy for details in the photos for which participants received no misinformation, there was no significant difference between HC users (M = 4.19, SD = .680) and naturally cycling women (M = 4.23, SD = .913), t(90) = .162, p = .872.

3.2.2 DRM Word List Paradigm. Critical lure endorsement errors in HC users (M = 64.3%, SD = 18.7%) was not statistically different from naturally cycling women (M = 61.8%, SD = 22.4%), t(90) = .47, p = .639, d = .12. Presented word correct endorsement was similar in HC users (M = 64.0%, SD = 19.5%) and naturally cycling women (M = 64.1%, SD = 14.9%),

$t(90) = 0.01$, $p = .993$, $d = .00$. Endorsement errors of distractor words (neither presented nor critical lures) was not statistically significantly higher in HC users (M = 22.6%, SD = 20.2%) compared to naturally cycling women (M = 20.2%, SD = 19.0%), $t(90) = 0.50$, $p = .622$, $d = .12$. On these tasks, equality of group variance assumptions were not violated (Levene ps > 0.1).

In a signal detection analysis of DRM using critical lures as "false alarms" and presented word endorsement as "hits." The signal detection index d-prime (d') was calculated for each participant by subtracting the standardized false alarm rate from the standardized true positive rate ($Z_{hits} - Z_{false\ alarms}$). Higher d' indicates better discrimination between presented words and critical lures. On this task, equality assumptions were not violated (O'Brien, Brown-Forsythe, Levene, and Bartlett test ps > 0.1), and performance (d') was not significantly different between HC (M = -0.01, SD = 0.32) and NC (M = 0.06, SD = 0.50) women, $t(90) = .58$, $p = 0.56$, d = 0.16.

3.3 Menstrual Phase and Memory Distortion

The effect of menstrual phase was also tested by comparing subgroups of NC women to each other divided by menstrual phase (follicular, luteal, possibly ovulating). The follicular and luteal groups were compared to one another, and Student's t found no significant differences in overall or source-confirmed false memory in the misinformation paradigm, or discriminating presented words from critical lures (d') in the DRM paradigm, all ps > 0.1. Women with self-reported irregular cycles were excluded from this analysis.

All naturally-cycling women were included in a regression analysis describing the relationship between cycle day and memory score. No significant relationship was found between cycle day and overall false memory, source-confirmed false memory, or d' score, all ps

> 0.05. The non-significant difference in overall false memory during each menstrual phase is depicted in Figure 3.

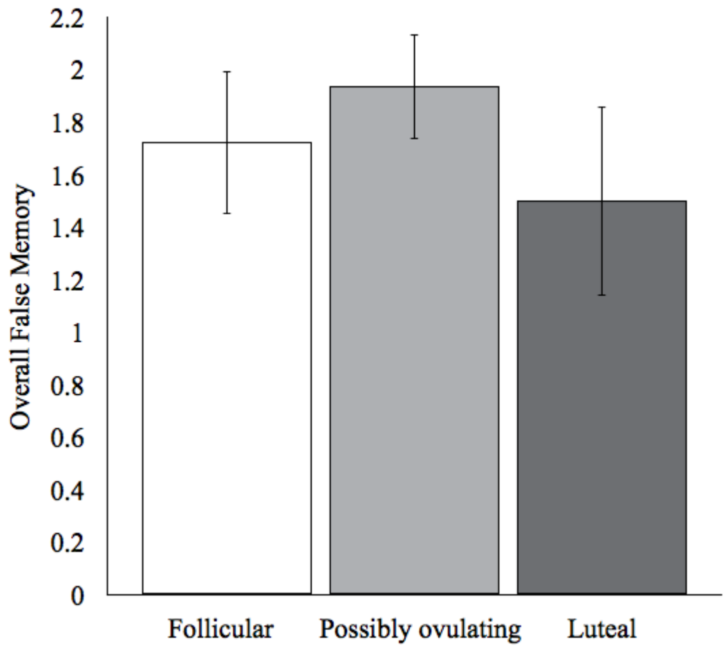

Figure 5. Mean overall false memory on the misinformation task as it varies through the menstrual cycle. No significant differences were found between naturally-cycling women at the three main phases of the cycle. Error bars represent standard errors.

3.4 Possible Selection Confounds

Because we were not able to randomly assign hormonal contraception, there is a concern that those who chose to use hormonal contraception might be different from those who did not on some other third variable. For that reason, we compared the two groups on age, SAT scores, political orientation, and a number of personality measures: the Creative Experiences Questionnaire (CEQ; Merckelbach, Horselenberg, & Muris, 2001), Dissociative Experiences Scale (DES-C; Wright & Loftus, 1999), Mindful Attention Awareness Scale (MAAS;Carlson & Brown, 2005), Tellegen Absorption Scale (TAS: Tellegen & Atkinson, 1974), Basic Empathy

Scale (BES; Jolliffe & Farrington, 2006), and Swedish Scale of Personality (SSP; Gustavsson et al., 2000). On all measures, HC and NC women did not differ, all *p*s > 0.1.

4. Discussion

We found that hormonal contraceptive users are less susceptible to false memories in a misinformation paradigm compared to naturally-cycling women. To our knowledge this is the first such finding. Two competing interpretations of these data are possible: It may be the case that fewer false memories in HC users reflect stronger, more accurate veridical memory for the details of the original story and the misinformation phase, which allowed them to reject the misinformation instead of forming a false memory. Alternatively, it may be the case that the misinformation details were encoded weakly in HC users so that they failed to integrate them into the original memory. This latter interpretation is supported by evidence from Nielsen et al. (2011), in which HC users remembered significantly fewer details of an emotional story, also with a narrative, compared to NC women. Because in our study HC and NC groups recalled equal numbers of details in the original photos in the absence of misinformation, it may be that this tendency to remember fewer details could be specific to stimuli in narrative form, as in our misinformation narratives and the Nielsen et al. (2011) stories. Our evidence suggests that the two groups did not differ in how they encoded information at the photographic event stage, but at the misinformation narratives stage, when HC women incorporated fewer misinformation details into the original narrative than did NC women.

We also compared performance between HC and NC women on the DRM task, and found no differences in memory as measured by the sensitivity index *d'* (measuring the ability to discriminate between critical lures and presented words). Ample previous literature has shown verbal memory (memory for words) can be influenced by estrogen levels, with evidence showing estrogen therapy increasing verbal memory in postmenopausal women (Kampen and Sherwin, 1994; Resnick et al., 1998; Wolf et al., 1999) and further evidence showing a positive correlation between endogenous estrogen and verbal fluency in premenopausal women (Maki et al., 2002). One study previously reported a beneficial effect of HC on verbal memory (Mordecai et al., 2008), however, we failed to observe any differences in verbal memory using the DRM task, and also did not detect any differences in false memories as indexed by the DRM task. Our findings in the relatively unemotional DRM task are congruent with those of Nielsen et al.'s (2011) neutral condition, in which no memory differences were seen in HC women compared to NC women.

Because the HC participants in our study appeared to differ from NC women on encoding of the narrative part of the misinformation task, rather than at the photographic slideshow, it may be the case that HC has a stronger effect on memory for narratives than non-narrative stimuli. Our null findings in the non-narrative DRM task are also consistent with this hypothesis. The Nielsen et al. (2011) finding previously described in which HC women differed from NC women also involved a narrative as the encoding stimulus, just as the misinformation narratives in this study did. Thus, it may be the case that narrative stimuli are more affected by HC use than other types of encoding stimuli. For that reason, future research could examine whether HC and NC women differ on autobiographical narrative memory tasks.

One limitation of the study is that participants were not randomly assigned to take hormone contraception, or not. This raises the possibility that women who chose HC are different in some way from the other participants. However, we found no such differences between HC and NC groups with regards to age, SAT scores, political orientation, or a number of relevant personality measures. Another concern might be that the source-confirmed false memory showed a smaller (and marginal) group difference compared overall false memory ($d = .32$ compared to .48). However, such a narrowing of group differences following a source test is not unusual and the same phenomena has been found when comparing older adults to younger adults (Wylie et al., 2013) and individuals with superior memory to controls (Patihis et al., 2013).

Future investigations may also explore whether the effect reported here is due to differences in memory encoding, consolidation, or retrieval by investigating the relationship between HC use and false memories at different time points and over longer retention intervals. In a placebo-controlled crossover design with encoding and retrieval sessions spaced far apart (>24h), it would be possible to discern whether the effect observed here is associated with HC influencing encoding or retrieval. It may also be important for future investigators to consider the type of HC used (e.g., oral contraceptives versus vaginal ring), the presence or absence of ethinyl estradiol in the HC used, the role of different progestational agents (e.g., levonorgestrel- versus etonogestrel-containing HCs), and/or whether oral contraceptive users are using hormone-containing pills or inactive (“placebo” week) pills. Menstrual phase effects may also be explored with more precise phase measurements that use biological markers of phase.

6. Conclusions

In summary, we demonstrate here the first evidence that HC is associated with a reduction in false memories. Unlike experiments demonstrating an effect of HC on emotional memory, this finding cannot be attributed to HC's well-documented effects on the stress response. Instead, we provide here evidence that HC use is associated with changes to the "verbatim" and "gist" memory processing mechanisms, leading to an overall decrease in false memories.

Authorship

L.P. created the overall study design and was responsible for data collection with the help of research assistants. L.P. and N.P. adapted the DRM word lists with help from other collaborators; L.P. adapted the misinformation paradigm for this study. N.P. conceived of the initial experimental question. L.P. and N.P. performed data analysis. S.E.N. contributed to the framing of the manuscript, background research, and drafted sections of the manuscript. All 3 authors contributed to interpreting the data, and to writing and editing the final draft.

Acknowledgments

Many thanks to Elizabeth Loftus, Craig Stark, Yoko Okado, Steven Frenda, and Rebecca Nichols for their help related to memory distortion materials; and to all the research assistants, including Fellows of University of California at Irvine's Undergraduate Research Opportunity Program. This research was supported by the National Science Foundation Graduate Research Fellowship Program (LP), and a Sigma-Xi Grant-in-Aid (LP).

References

Beck, K. D., McLaughlin, J., Bergen, M. T., Cominski, T. P., Moldow, R. L., & Servatius, R. J. (2008). Facilitated acquisition of the classically conditioned eyeblink response in women taking oral contraceptives. *Behavioural Pharmacology, 19*, 821--828.

Bentz, D., Michael, T., Wilhelm, F. H., Hartmann, F. R., Kunz, S., Rudolf van Rohr, I. R., & de Quervain, D. J.-F. (2013.) Influence of stress on fear memory processes in an aversive differential conditioning paradigm in humans. *Psychoneuroendocrinology*, 38, 117), 1186-1197.

Cahill, L.., & van Stegeren, A. (2003). Sex-related impairment of memory for emotional events with beta-adrenergic blockade. *Neurobiology of Learning and Memory,* 79, 81-88.

Carlson, L. E., & Brown, K. W. (2005). Validation of the Mindful Attention Awareness Scale in a cancer population. Journal of psychosomatic research, 58, 29-33.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, 58, 17-22.

Dewhurst, S. A., Anderson, R. J., & Knott, L. M. (2012). A gender difference in the false recall of negative words: Women DRM more than men. *Cognition & Emotion*, 26, 65-74.

Gallo, D. A. (2010). False memories and fantastic beliefs: 15 years of the DRM illusion. *Memory & Cognition*, 38, 833-848.

Gustavsson, J. P., Bergman, H., Edman, G., Ekselius, L., Von Knorring, L., & Linder, J. (2000). Swedish universities Scales of Personality (SSP): construction, internal consistency and normative data. Acta Psychiatrica Scandinavica, 102, 217–225.

Hampson, E., & Morley, E. E. (2013). Estradiol concentrations and working memory performance in women of reproductive age. *Psychoneuroendocrinology*, 38, 2897-2904.

Holloway, J. L., Beck, K. D, & Servatius, R. J. (2011). Facilitated acquisition of the classically conditioned eyeblink response in females is augmented in those taking oral contraceptives. *Behavioural Brain Research*, 216, 301-307.

Jolliffe, D., & Farrington, D. P. (2006). Development and validation of the Basic Empathy Scale. Journal of Adolescence, 29, 589–611.

Kampen, D. L., & Sherwin, B. B. (1994). Estrogen use and verbal memory in healthy postmenopausal women. *Obstetrics & Gynecology*, 83, 979-983.

Kirschbaum, C., Kudielka, B. M., Gaab, J., Schommer, N.C., & Hellhammer, D. H. (1999). Impact of gender, menstrual cycle phase, and oral contraceptives on the activity of the Hypothalamus-Pituitary-Adrenal axis. *Psychosomatic Medicine*, 61, 154-162,

Kudielka, B. M. & Kirschbaum, C. (2005). Sex differences in the HPA axis responses to stress: A review. *Biological Psychology*, 113-132.

Kuhlmann, S., & Wolf, O. T. (2005). Cortisol and memory retrieval in women: influence of menstrual cycle and oral contraceptives. *Psychopharmacology*, 183, 65-71.

Lobo, R. A. & Stanczyk, F. Z. (1994). New knowledge in the physiology of hormonal contraceptives. *American Journal of Obstetrics and Gynecology*, 170, 1499-1507.

Loftus, E. F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory*, 12, 361-366.

Maki, P. M., Rich, J. B., & Rosenbaum, R. S. (2002). Implicit memory varies across the menstrual cycle: estrogen effects in young women. *Neuropsychologia*, 40, 518-529.

Merckelbach, H., Horselenberg, R., & Muris, P. (2001). The Creative Experiences Questionnaire (CEQ): A brief self-report measure of fantasy proneness. Personality and Individual Differences, 31, 987–996.

Merz, C. J., Stark, R., Vaitl, D., Tabbert, K., & Wolf, O. T. (2013). Stress hormones are associated with the neuronal correlates of instructed fear conditioning. *Biological Psychology*, 92, 82-89.

Merz, C. J., Tabbert, K., Schweckendiek, J., Klucken, T., Vaitl, D., Stark, R., & Wolf, O. T. (2012). Oral contraceptive usage alters the effects of cortisol on implicit fear learning. *Hormones and Behavior*, 62, 531-538.

Merz, C. J., Wolf, O. T., Schweckendiek, J., Klucken, T., Vaitl, D., & Stark, R. (2013). Stress differentially affects fear conditioning in men and women. *Psychoneuroendocrinology*, 38, 2529-2541.

Mordecai, K. L., Rubin, L. H., & Maki, P. M. (2008). Effects of menstrual cycle phase and oral contraceptive use on verbal memory. *Hormones and Behavior*, 54, 286-293.

Nielsen, S. E., Ahmed, I., & Cahill, L. (In press.) Post-learning stress differentially affects memory for emotional gist and detail in naturally cycling women and women on hormonal contraceptives. *Behavioral Neuroscience*.

Nielsen, S. E., Ertman, N., Lakhani, Y. S., & Cahill, L. (2011). Hormonal contraception usage is associated with altered memory for an emotional story. *Neurobiology of Learning and Memory*, 96, 378-384.

Nielsen, S. E., Segal, S. K., Worden, I. V., Yim, I. S., & Cahill, L. (2013). Hormonal contraception use alters stress responses and emotional memory. *Biological Psychology*, 92, 257-266.

Okado, Y. & Stark, C. E. L. (2005). Neural activity during encoding predicts false memories created by misinformation. *Learning & Memory*, 12, 3-11.

Patihis, L., Frenda, S. J., LePort, A. K. R., Petersen, N., Nichols, R. M., Stark, C. E. L., McGaugh, J. L., & Loftus, E. F. (2013). False memories in highly superior autobiographical memory individuals. *Proceedings of the National Academy of Sciences*, 110, 20947-20952.

Resnick, S. M., Maki, P. M., Golski, S., Kraut, M. A., & Zonderman, A. B. (1998). Effects of estrogen replacement therapy on PET cerebral blood flow and neuropsychological performance. *Hormones and Behavior*, 34, 171-182.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology,* 21, 803-814.

Roediger, H. L., Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin & Review*, 8, 385-407.

Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences (" absorption"), a trait related to hypnotic susceptibility. Journal of abnormal psychology, 83, 268.

Turner, A. I., Keating, C. L., & Tilbrook, A. J. (2012.) Sex differences and the role of sex steroids in sympatho-adreno medullary system and hypothalamo-pituitary adrenal axis responses to stress. In S. M. Kahn (Ed.), *Sex Steroids*, 115-136.

Wolf, O. T., Kudielka, B. M., Hellhammer, D. H., Törbera, S., McEwen, B. S., & Kirschbaum, C. (1999). Two weeks of transdermal estradiol treatment in postmenopausal elderly women and its effect on memory and mood: verbal memory changes are associated with the treatment induced estradiol levels. *Psychoneuroendocrinology*, 24, 727-741.

Wright, D. B., & Loftus, E. F. (1999). Measuring dissociation: Comparison of alternative forms of the dissociative experiences scale. American Journal of Psychology, 112, 497-519.

Wylie, L. E., Patihis, L., McCuller, L. L., Davis, D., Brank, E. M., Loftus, E. F., & Bornstein, B. H. (2014). Misinformation effects in older versus younger adults: A meta-analysis and review. In M. P. Toglia, D. F. Ross, J. Pozzulo, & E. Pica (Eds) *The Elderly Eyewitness in Court*, UK: Psychology Press.

Zoladz, P. R., Peters, D. M., Kalchik, A. E., Hoffman, M. M., Aufdenkampe, R. L., Woelke, S. A., Wolters, N. E., & Talbot, J. N. (2014). Brief, pre-learning stress reduces false memory production and enhances true memory selectively in females. *Physiology & Behavior*, 128, 270-276.