

The Effects of Hormonal Contraception on Auditory Emotional Memory

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BACKGROUND

- The use of hormonal contraception has been shown to alter both brain structure and function.
- Emotional memory research has had mixed findings - some have found increased memory accuracy for negative emotional events when compared to a neutral event¹, while others have found that emotional memories are more susceptible to misinformation and thus decreased accuracy².
- Previous studies regarding emotional memory have discovered that women on an oral hormonal contraceptive (OC) correctly recall more gist information of an emotional story, whereas naturally-cycling women (NC) will be more likely to correctly remember more details of the same story³. However, these studies have utilized primarily visual stimuli (a video or a slideshow with narration) and have not isolated auditory stimuli alone.
 - Gist information is information that, when changed or omitted, alters the main plot of the story.
 - Details are all other aspects of the story that can be recalled, and are often more trivial in nature (do not alter the main plot when changed or omitted).

Question: Do women on OC differ from NC women when recalling an auditory emotional memory?

Hypothesis: Women on an oral hormonal contraceptive will have a more accurate memory for details of an auditory emotional story, whereas naturally-cycling women will have a more accurate memory for gist information of the same story. There is no predicted difference in gist or detail memory accuracy between groups for a neutral auditory story.

METHODS

Participants: Female participants ($N = 90$; 18- to 33-years old, $M = 20.5$, $SD = 2.4$), who were either naturally-cycling ($N = 45$; NC) for at least the last 3 months (no form of hormonal birth control) or on an oral hormonal contraceptive ($N = 45$; OC) for at least the last 3 months (either combined or progestin-only).

- Following the eligibility questionnaire, participants completed a Positive and Negative Affect Scale (PANAS) in order to assess their baseline affective state.
- They were then randomly assigned to hear a narrated recording of a story with either emotional or neutral content.
- Following the first narration, they completed a second PANAS and then were asked to freely recall all story elements that they remember.
- They then completed a demographics questionnaire.
- Next, they heard the second recorded narration (whichever story they had not heard prior).
- Following the second story, they completed a third PANAS and were asked to perform free recall for the story they had just heard.

The two stories were similar in length and contained similar amounts of detail and gist elements.

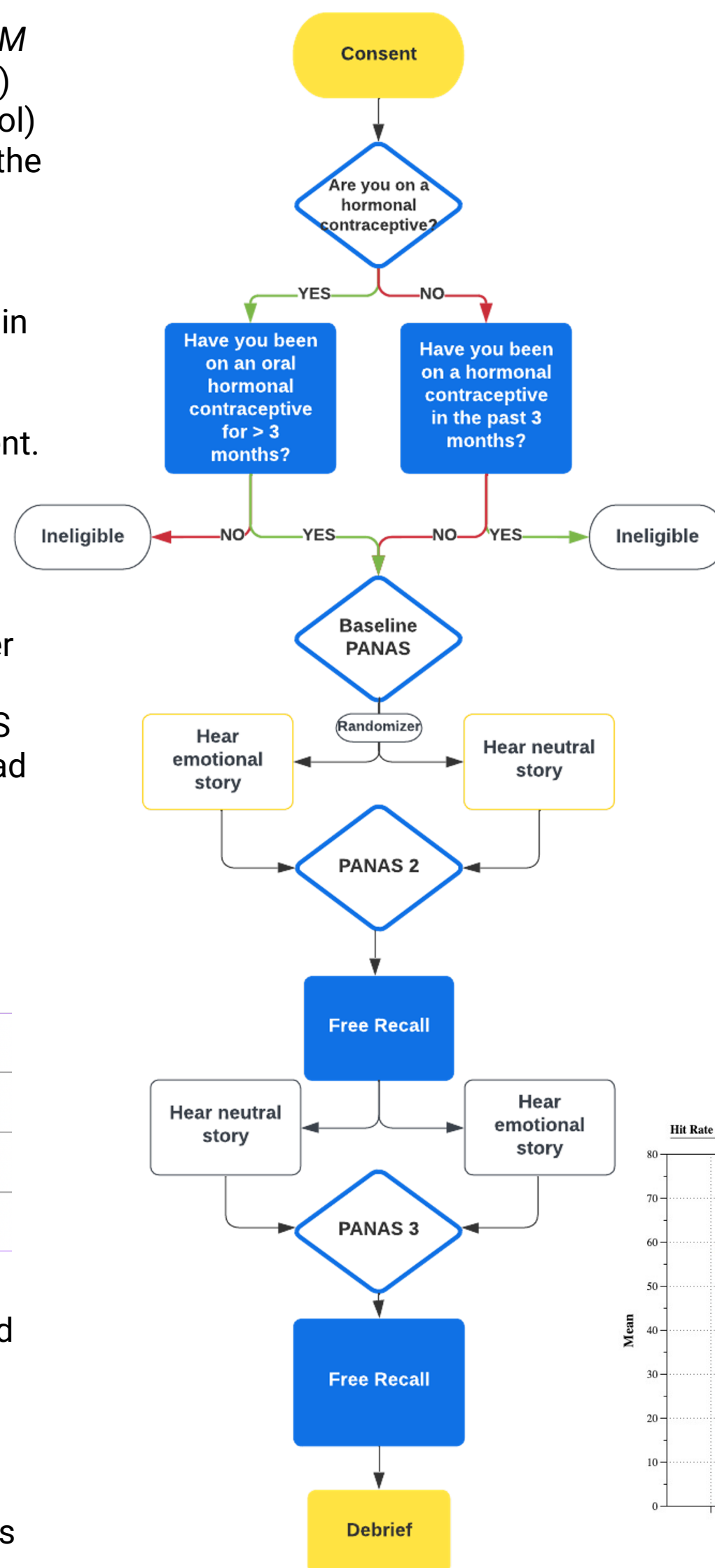
	Total Correct Categories			Total Incorrect Categories		
	Gist	Detail	Total	Gist	Detail	Total
Negative Story	13	31	44	8	28	36
Neutral Story	13	26	39	6	19	25

Responses were analyzed by two independent judges, who had an 83% agreement rate, which is considered near-perfect agreement⁴.

Analysis Methods: A Signal Detection Theory (SDT) model was employed to assess participants' recall accuracy. The recalls were considered more accurate when Hit Rates (HR) were high and False Alarm Rates (FAR) were low. The following equations were used:

$$\frac{\text{Number of Hits}}{(\text{Number of Hits} + \text{Number of Misses})} = \text{Hit Rate}$$

$$\frac{\text{Number of False Alarms}}{(\text{Total Possible Alarms})} = \text{False Alarm Rate}$$



The following stories were used as the scripts for the narrated stimuli. The emotional story was adapted from Cahill et al. (1994)⁵.

Emotional Version

- Robin and her son, Teddy, are leaving their New York apartment on a cold December morning
- She is taking him to visit his father's workplace, which is a 20 minute walk from their home
- The father is a laboratory technician at Victory Memorial Hospital
- They look both ways before crossing Broadway, a busy street.
- While crossing the road, Teddy is struck by a white Mercedes, which critically injures him. A man at a nearby bus stop calls 911 for an ambulance.
- At the hospital, the staff prepare the emergency room, to which Teddy is rushed
- An image from a brain scan machine shows severe bleeding in the left side of Teddy's brain
- All morning long, Dr. Smith's surgical team struggled to save Teddy's life
- Specialized surgeons were able to stop the bleeding in his brain, though he did sustain blindness in his right eye.
- After the surgery, while the father stayed with Teddy, the mother left to phone her other child, Samantha's, pre-school
- Feeling distraught, she phones the pre-school to tell them she will pick up Samantha as soon as possible.
- Heading to pick up her child, she hails a taxi at the number nine bus stop.

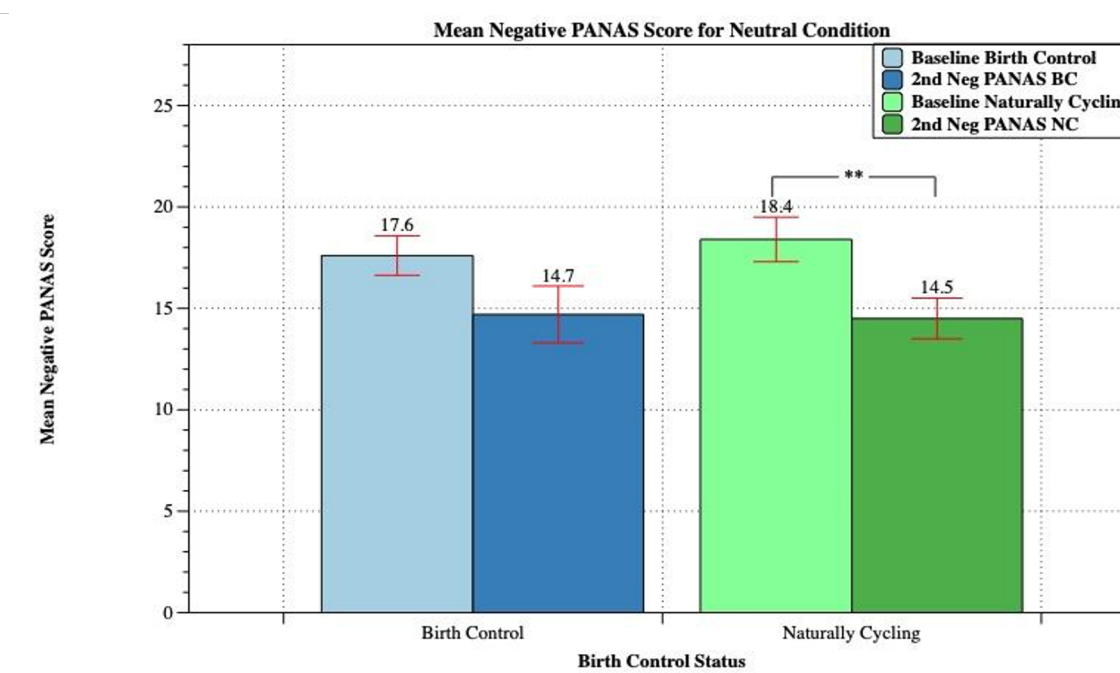
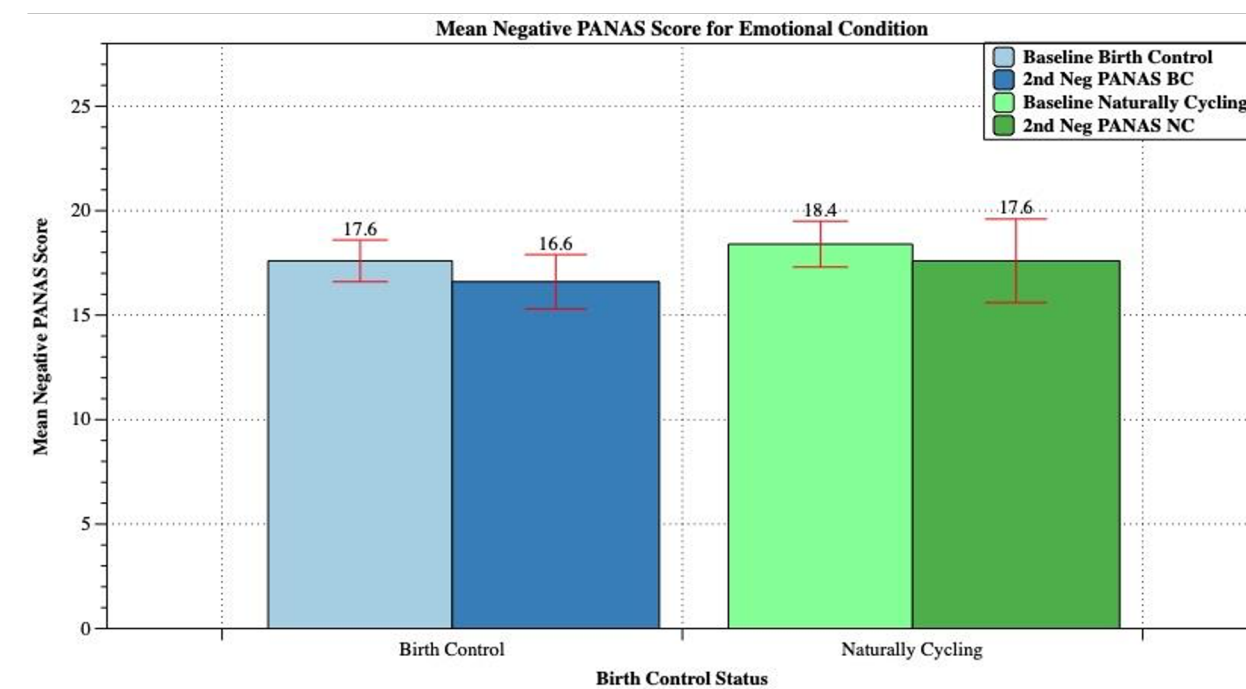
Neutral Version

- Two women decide to go to the mall after they get off work on Sunday afternoon
- Susan picked up Kate in her red BMW at 4:00
- They headed to Westfield mall in Placerville.
- Once they got to the mall, they headed straight for Dottie's clothing store for a big sale.
- At the store they tried on lots of different sweaters, but neither of them bought anything.
- After that, they decided to go to the mall's candy shop because Kate had a gift certificate for \$10.00.
- They looked around the shop for a while and tried different samples
- They each decided on buying an assortment of chocolate and split a pound of saltwater taffy.
- Next, they decided to get some dinner at a local diner located down the street from the mall.
- Once there, Kate ordered a bacon cheeseburger and fries, and Susan ordered a garden salad.
- While enjoying their meals they talked about work.
- After they finished, Susan dropped Kate off at her house before heading home herself.

RESULTS

Emotional Arousal

- Neither OC women [$t(44) = .5$, $p = .60$] nor NC women [$t(33) = .3$, $p = .73$] showed a significant change in their negative PANAS scores between baseline (OC: $M = 17.51$, $SD = 6.51$; NC: $M = 18.36$, $SD = 7.38$) and stimulus (OC: $M = 16.64$, $SD = 6.16$; NC: $M = 17.57$, $SD = 9.01$) for the emotional condition.
- However, for the neutral stimulus, naturally-cycling women showed a decrease in negative arousal scores from baseline ($M = 18.36$, $SD = 7.38$) to after the stimulus was presented ($M = 14.54$, $SD = 4.85$), [$t(64) = 3$, $p < .05$].

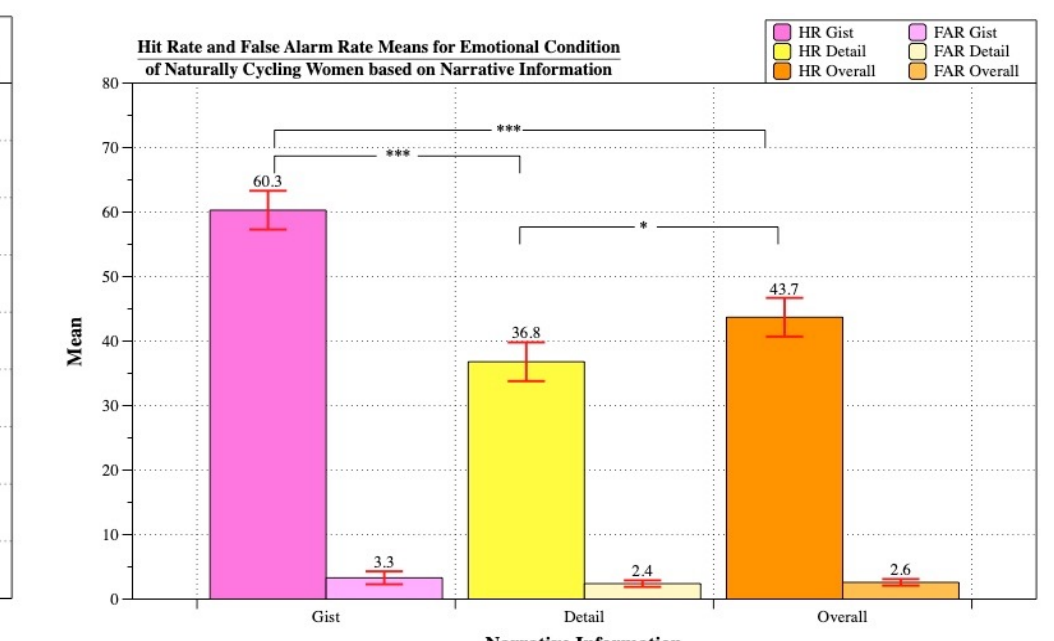
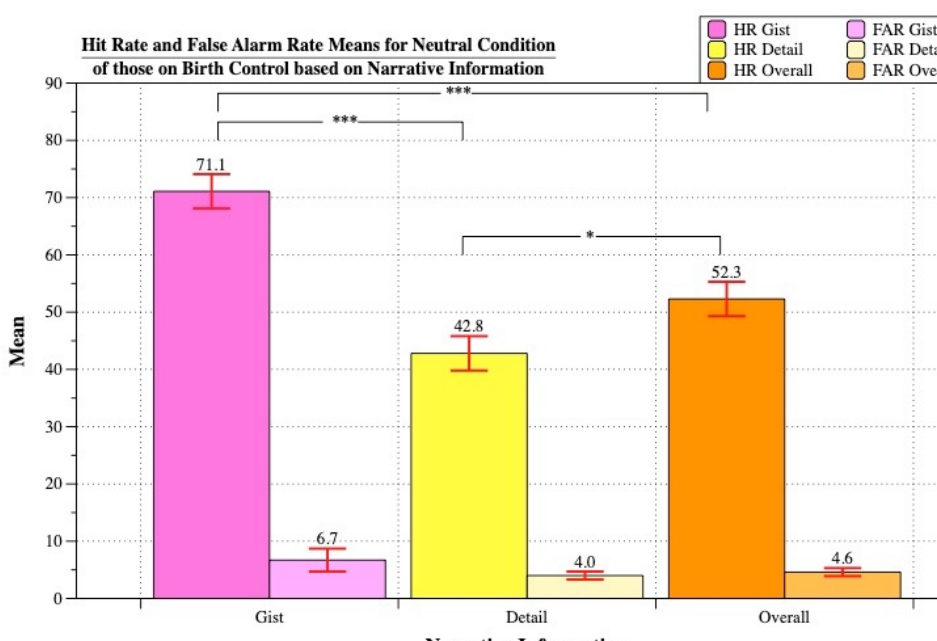
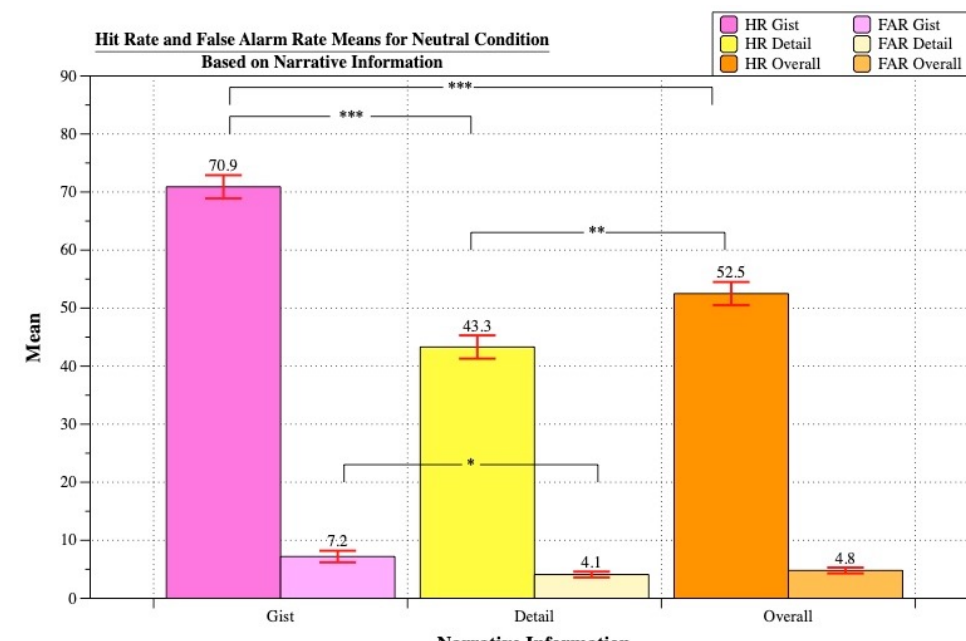
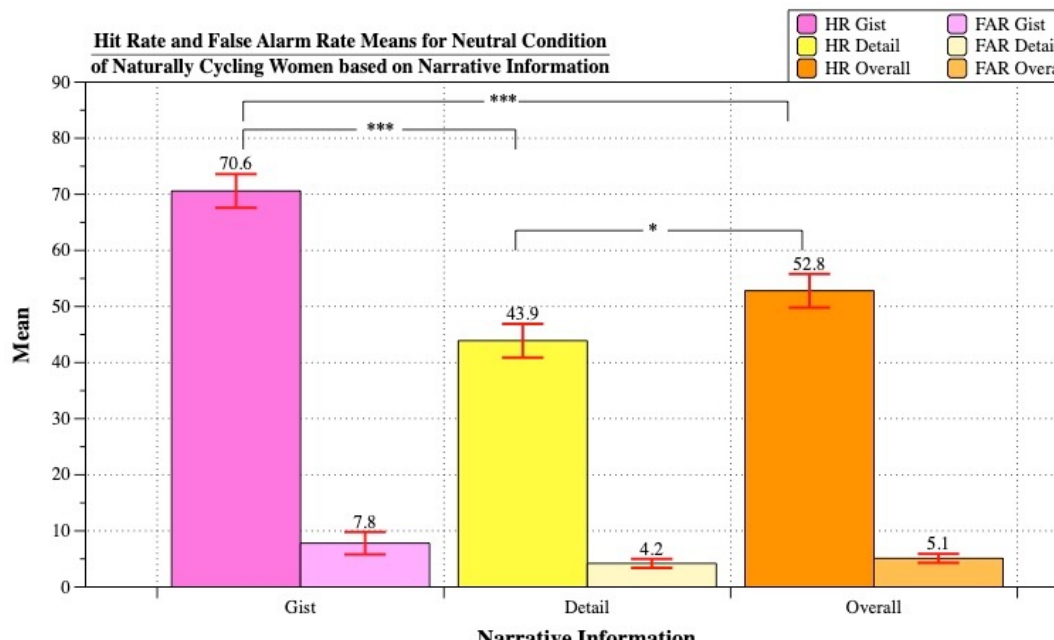
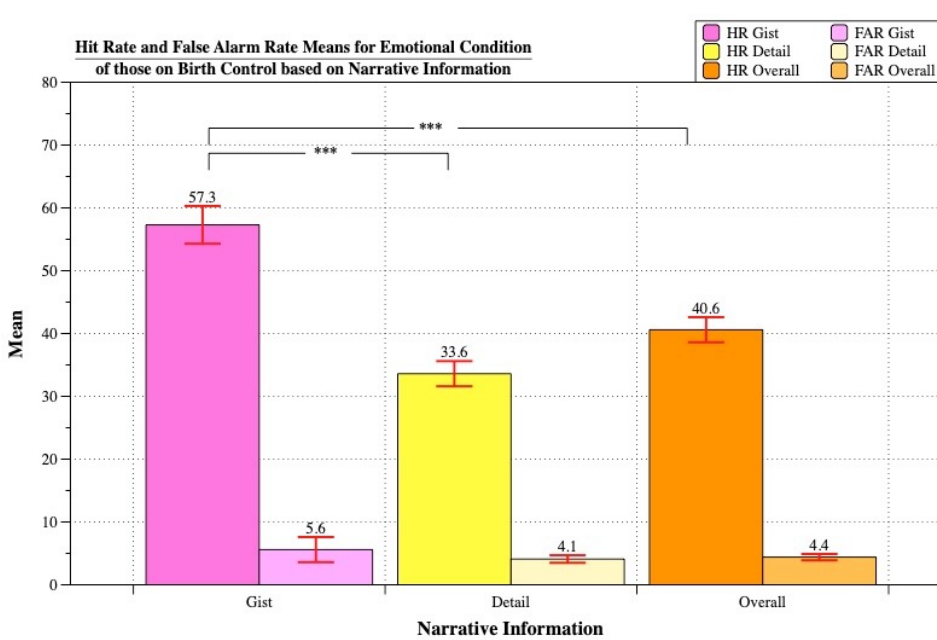
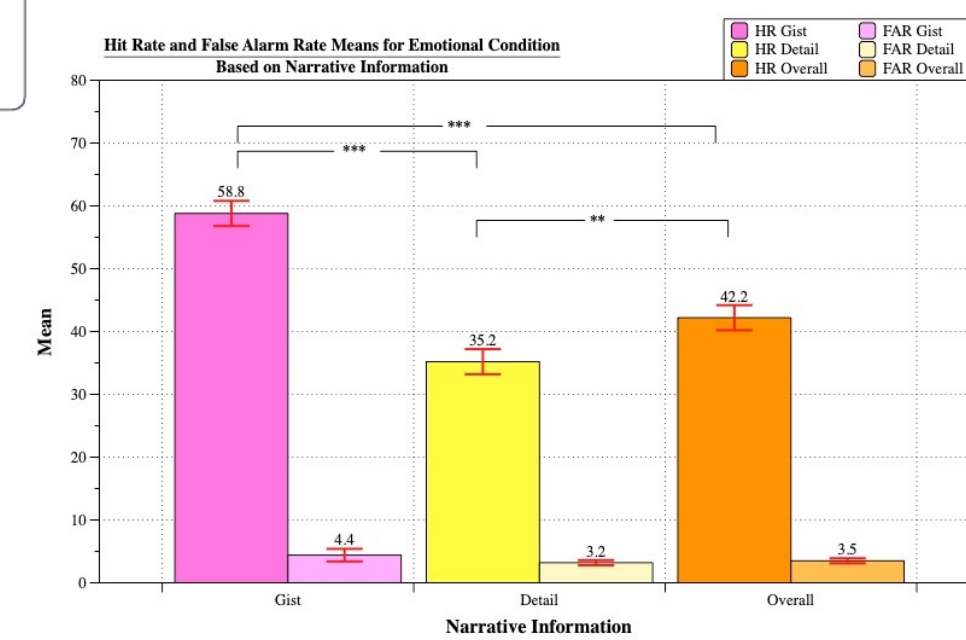


Recall Accuracy

- There were no significant differences in HRs between OC and NC women across any condition.
- There was a significant difference in FARs between OC women ($M = .04$, $SD = .04$) and NC women ($M = .03$, $SD = .04$) for the emotional condition [$t(88) = 2$, $p < .05$].
- There was no significant difference in FARs between OC women ($M = .05$, $SD = .05$) and NC women ($M = .05$, $SD = .05$) for the neutral condition [$t(87) = -.43$, $p = .67$].

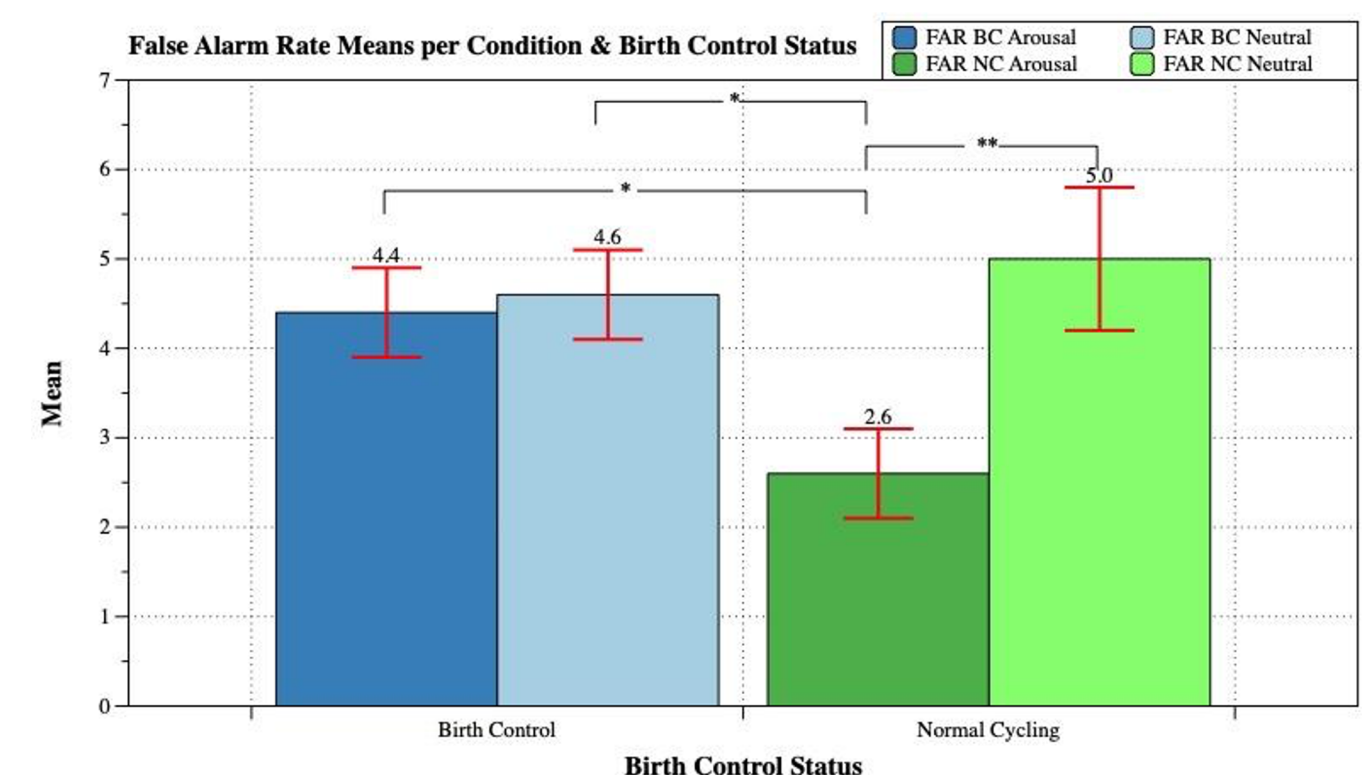
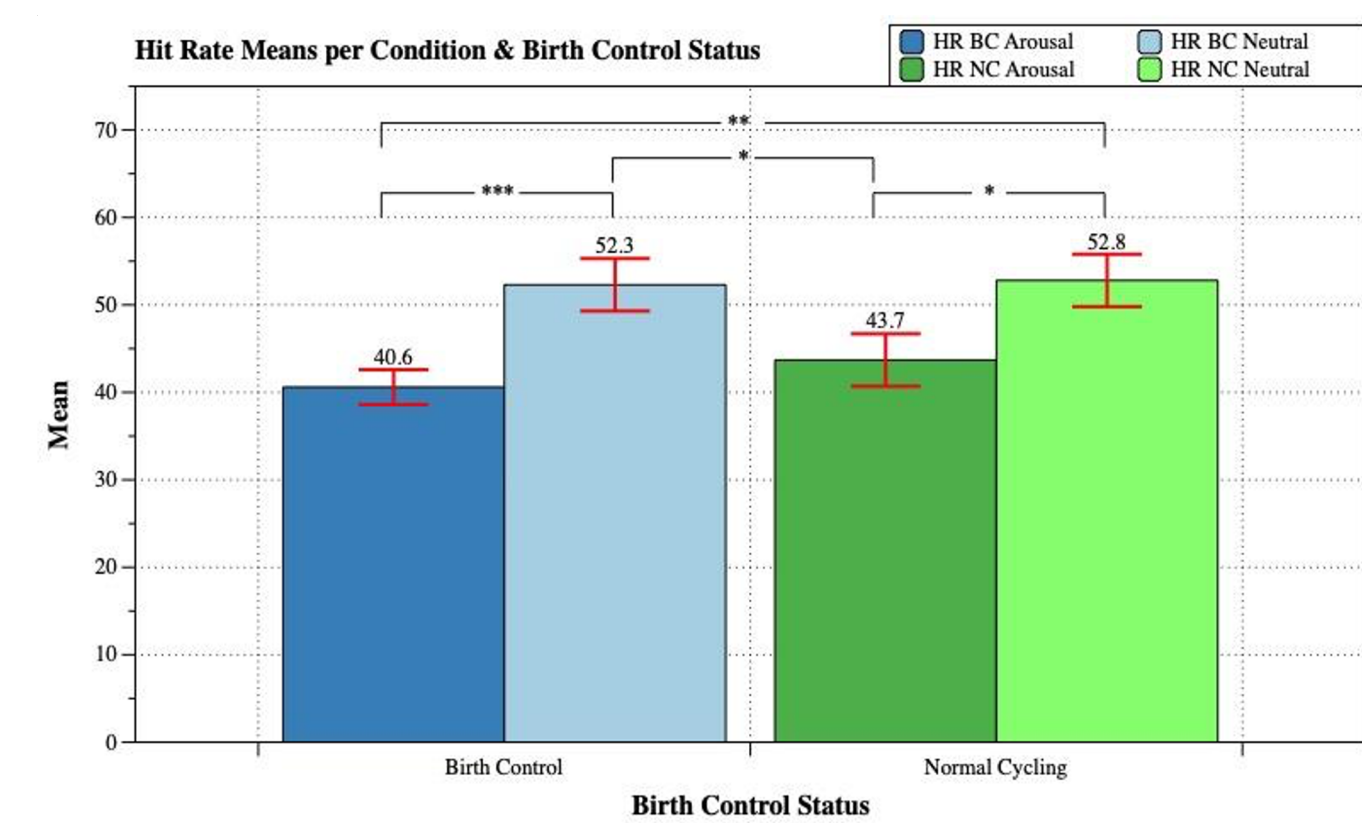
		Emotional		Neutral	
		Gist	Detail	Gist	Detail
Emotional Content	Hit Rate	.59 (.22)	.35 (.16)	.41 (.15)	.44 (.18)
	OC Hit Rate	.57 (.20)	.34 (.15)	.60 (.23)	.37 (.17)
	NC Hit Rate	.60 (.23)	.37 (.17)	.60 (.23)	.37 (.17)
	False Alarm Rate	.04 (.10)	.03 (.04)	.04 (.04)	.03 (.04)
	OC False Alarm Rate	.06 (.11)	.04 (.04)	.04 (.04)	.03 (.04)
	NC False Alarm Rate	.03 (.09)	.02 (.03)	.04 (.04)	.03 (.04)
Neutral Content	Hit Rate	.71 (.17)	.43 (.21)	.71 (.17)	.43 (.21)
	OC Hit Rate	.71 (.17)	.43 (.21)	.71 (.17)	.43 (.21)
	NC Hit Rate	.71 (.18)	.44 (.23)	.71 (.18)	.44 (.23)
	False Alarm Rate	.07 (.12)	.04 (.05)	.07 (.12)	.04 (.05)
	OC False Alarm Rate	.07 (.11)	.04 (.05)	.07 (.11)	.04 (.05)
	NC False Alarm Rate	.08 (.13)	.04 (.05)	.08 (.13)	.04 (.05)

		OC		NC	
		M (SD)	M (SD)	M (SD)	M (SD)
Emotional Content	Hit Rate	.41 (.15)	.44 (.18)	.41 (.15)	.44 (.18)
	Gist Hit Rate	.57 (.20)	.60 (.23)	.57 (.20)	.60 (.23)
	Detail Hit Rate	.34 (.15)	.37 (.17)	.34 (.15)	.37 (.17)
	False Alarm Rate	.04 (.04)	.03 (.04)	.04 (.04)	.03 (.04)
	Gist False Alarm Rate	.06 (.11)	.03 (.09)	.06 (.11)	.03 (.09)
	Detail False Alarm Rate	.04 (.04)	.02 (.03)	.04 (.04)	.02 (.03)
Neutral Content	Hit Rate	.52 (.18)	.53 (.20)	.52 (.18)	.53 (.20)
	Gist Hit Rate	.71 (.17)	.71 (.18)	.71 (.17)	.71 (.18)
	Detail Hit Rate	.43 (.20)	.44 (.23)	.43 (.20)	.44 (.23)
	False Alarm Rate	.05 (.05)	.05 (.05)	.05 (.05)	.05 (.05)
	Gist False Alarm Rate	.07 (.11)	.08 (.13)	.07 (.11)	.08 (.13)
	Detail False Alarm Rate	.04 (.05)	.04 (.05)	.04 (.05)	.04 (.05)



RESULTS cont.

		Emotional Content		Neutral Content	
		M (SD)	M (SD)	M (SD)	M (SD)
Oral Contraceptive	Hit Rate	.41 (.15)	.52 (.18)	.41 (.15)	.44 (.18)
	Gist Hit Rate	.57 (.20)	.71 (.17)	.57 (.20)	.71 (.17)
	Detail Hit Rate	.34 (.15)	.43 (.20)	.34 (.15)	.43 (.20)
	False Alarm Rate	.04 (.04)	.05 (.05)	.04 (.04)	.05 (.05)
	Gist False Alarm Rate	.06 (.11)	.07 (.11)	.06 (.11)	.07 (.11)
	Detail False Alarm Rate	.04 (.04)	.04 (.05)	.04 (.04)	.05 (.05)
Naturally Cycling	Hit Rate	.44 (.18)	.53 (.2)	.44 (.18)	.53 (.2)
	Gist Hit Rate	.60 (.23)	.71 (.18)	.60 (.23)	.71 (.18)
	Detail Hit Rate	.37 (.17)	.44 (.23)	.37 (.17)	.44 (.23)
	False Alarm Rate	.03 (.04)	.05 (.05)	.03 (.04)	.05 (.05)
	Gist False Alarm Rate	.03 (.09)	.07 (.12)	.03 (.09)	.07 (.12)
	Detail False Alarm Rate	.02 (.03)	.04 (.05)	.02 (.03)	.04 (.05)



DISCUSSION

- Contrary to previous studies, these findings did not demonstrate a significant difference in recall accuracy for auditory emotional memories between naturally-cycling women and women on an oral hormonal contraceptive.
- The findings did demonstrate increased recalled elements (both correct and incorrect) for the neutral story compared to the emotional story.
- Participants were also more accurate when recalling gist information compared to detail information, regardless of narrative content.

REFERENCES

- Kensinger, E. A. (2007). Negative emotion enhances memory accuracy: Behavioral and neuroimaging evidence. *Current Directions in Psychological Science*, 16(4), 213-218.
- Kaplan, R. L., Van Damme, I., Levine, L. J., & Loftus, E. F. (2016). Emotion and false memory. *Emotion Review*, 8(1), 8-13.
- 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(2), 378-384.
- McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia Medica*, 276-282.
- Cahill, L., Prins, B., Weber, M., & McGaugh, J. L. (1994). β -Adrenergic activation and memory for emotional events. *Nature*, 371(6499), 702-704.

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