

Detecting the Scent of Androstenone with College Students and Evaluating Changes in Mood

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Author's Note

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Abstract

Previous studies have shown that the odor emitted by the human hormone androstenone can only be detected by approximately twenty to forty percent of adults (Knaapila et al., 2012). It has also been reported that androstenone elicits changes in mood, often specific to the sex of the participant (Lubke & Pause, 2014). When detected, the scent was reported as musky, reminiscent of sweat and/or urine (Lunde et al., 2009). We hypothesized that the data would reflect a detection rate close to fifty percent. We also hypothesized that there would be a significant correlation between negative emotions and male participants regardless of scent detection. Gaining a better understanding of the effects of hormones on emotions across genders could provide another framework from which to analyze interpersonal and social interactions between men and women. A sample of 105 undergraduate psychology students was asked whether a scent can be detected from a container provided to them. The experiment was conducted during preapproved lectures to allow participants to become preoccupied while being continuously exposed to the contents of the container. This el-

*ement of the experiment was essential, as the effect of hormones on mood can take anywhere from two to fifteen minutes. The container held water or a solution of human androstenone. An immediate self-response Likert scale rating strength of scent was submitted, including the participant's gender and provided condition symbol. After twenty minutes of uninterrupted exposure to the open container, participants completed a modified PANAS questionnaire to assess for mood. The results of this experiment may yield further information regarding the effect of human androstenone between males and females.*¹

Introduction

Androstenone is a volatile steroid produced in the testes, and is purported to aid the synthesis of male hormones (Claus, Weiler, & Herzog, 1994). Hormones and pheromones can elicit a physiological or emotional response by those that are exposed to them. Previous studies have noted a trend of negative emotional response in males to the presence of androstenone. The anabolic ties between androstenone and testosterone suggest that increased levels of androstenone indicate heightened levels of

¹Keywords: androstenone, effects on mood, gender, detectable smell

aggression and hostility (Lubke & Pause, 2014), which could account for a negative response in males.

Female subjects that were highly sensitive to the scent of androstenone reported it as urine-like as compared to the pleasant sweet musky scent described by female participants who were considered moderately “sensitive”. Women trained to detect the scent of androstenone by repeated exposure and identification later found male body odor more pleasing, thus supporting the hypothesis that androstenone serves as a sexual chemical signal (Pause et al., 1999). Knaapila et al. (2012) found that women who had experienced at least one sexual encounter rated the scent of androstenone more highly, supporting the hypothesis that females positive response in affect is due to associative learning and not strictly a physiological response elicited by chemo signaling.

The purpose of this study was to test the previous findings regarding the difference between male and female mood response and scent detection to androstenone to contribute data for further research in the field of hormones and behavior. We hypothesized that approximately 50% of participants would report the detection of a scent, and male participants would display a negative effect in response regardless of detection.

Method

Participants

Recruitment of Participants

Participants were actively enrolled in undergraduate courses in psychology. Students in these classes are frequently expected to engage in experiments, conduct experiments, or gather data. While participation was a requirement for the course, this study was only administered to 105 willing participants, as it is outside the grading criteria.

Materials and Procedure

Researchers utilized a modified version of the PANAS questionnaire (Watson et al., 1988), a self-report form for participants to rate how strongly an emotion applies to their present state, a Likert Scale assessing strength of scent detected, plastic containers (2 inches in diameter), cotton balls for solution distribution, androstenone solution, and water. Group symbol and sex of participant was included on both the PANAS and the Likert scale for strength of scent.

Collecting Data

The participants on one side of the room were provided with small transparent containers which held a cotton ball soaked with water. The second half of the participants had transparent containers which held a cotton ball that was wetted with an over the counter androstenone solution. The containers only differed in appearance with a randomly selected symbol drawn on the lid. At the beginning of a preapproved lecture, all participants were given two consent forms. The first was signed and collected; the second was for the participant to keep for his/her own personal records. Signed consent forms were stored in a manila folder. Participants were also given an anonymous Likert Scale questionnaire to assess the strength of scent detected that included a section for participant information, specifically gender, and an anonymous modified mood questionnaire to be filled out upon request. These questionnaires were handed out face down, so as not to increase demand effect in the data, and participants were asked to put the symbol of their lid on the questionnaires.

Participants that signed the consent form were then asked to open a small container that had been placed on their desk and sniff the contents three times. The participants were asked to respond to the scent scale immediately after. The participants then placed their open contain-

ers on their desks and attended to the lecture. After 20 minutes the participants were asked to fill out a modified mood questionnaire. Both questionnaires were collected at this time. Participants were informed as to whether they were in the experimental or control group, further questions were answered, and the lecture resumed. Completed anonymous questionnaires were placed in a separate folder from the consent forms.

Results

As shown in Table 1 and Table 2, an independent samples t-test was conducted to compare scent detection in the androstenone condition and the placebo condition. There was no significant difference between participants' detection of smell in the androstenone condition ($M = 1.95$, $SD = 0.94$) versus the placebo condition ($M = 2.17$, $SD = 0.88$), $t(103) = -1.26$, $p > .05$ (Figure 1).

As seen in Table 4, the only significant dependent variable was enthusiasm. Table 3 indicates that the androstenone condition reported higher amounts of enthusiasm than the placebo condition (see Figure 2). Both male and female participants reported higher levels of enthusiasm in the androstenone condition than in the placebo condition, or no significant difference across gender (see Table 5). Refer to Table 6 to view the two-way ANOVA used to test the effects of androstenone between gender and on enthusiasm. Results indicated enthusiasm as a significant factor. There was a significant main effect for enthusiasm, $F(1, 96) = 8.01$, $p = .01$. There was no significant main effect for gender, $F(1, 96) = 0.37$, $p > .05$. There is no significant interaction effect of gender and enthusiasm, $F(1, 96) = 0.000$, $p = 0.99$ (Figure 3).

A two-way ANOVA was also used to test gender and jitteriness on detection of androstenone scent and placebo (see Ta-

ble 7 and Table 8). There was no significant main effect on jitteriness, $F(1, 96) = .01$, $p > .05$. There was no significant main effect on gender, $F(1, 96) = 1.25$, $p > .05$. There was, however, a significant crossover interaction on jitteriness and gender, $F(1, 96) = 7.82$, $p = .01$ (Figure 4). Males were more jittery as a result of exposure to androstenone versus females. Females reported to be more calmed down after androstenone exposure than males because they reported less jittery feelings.

As indicated in Table 9, a two-way ANOVA was used to test gender and irritability on detection of androstenone scent and placebo. As seen in Table 10, there was no significant main effect on irritability, $F(1, 96) = .04$, $p > .05$. There was no significant main effect on gender, $F(1, 96) = .08$, $p > .05$. There was not a significant interaction between irritability and gender, but it was marginally significant, $F(1, 96) = 3.08$, $p = .08$ (Figure 5).

A two-way ANOVA was used to test gender and hostility on detection of androstenone scent and placebo (see Table 11). Table 12 shows that there was no significant main effect on hostility, $F(1, 96) = 0.18$, $p > .05$. There was no significant main effect on gender, $F(1, 96) = 1.32$, $p > .05$. There was not a significant interaction on gender and hostility and was not close enough to say it was marginally significant, $F(1, 96) = 1.93$, $p = .17$ (Figure 6).

As seen in Table 13, a two-way ANOVA was used to test gender and positivity to the androstenone scent and the placebo. By viewing Table 14, it is apparent that there was no significant main effect on positivity to androstenone or the placebo, but it was marginally significant, $F(1, 96) = 2.56$, $p > .05$. There was no significant main effect on gender, $F(1, 96) = .01$, $p > .05$. There was not a significant interaction between positivity to androstenone or the placebo and gender, $F(1, 96) = 0.95$, $p > .05$ (Figure 7). This positivity can be due

to the significance of the enthusiasm factor reported previously.

A two-way ANOVA was used to test gender and negativity to the androstenone scent and the placebo in Table 15. There was no significant main effect on negativity to androstenone or the placebo (see Table 16), $F(1, 96) = .06, p > .05$. There was no significant main effect on gender, $F(1, 96) = .071, p > .05$. There was, however, a significant interaction between negativity to androstenone or the placebo and gender, $F(1, 96) = 4.96, p = .03$ (Figure 8). This can be due to the negativity from hostility, jitteriness, and irritability.

Table 1
Scent Detection

Group Statistics					
	Androstenone or placebo	N	Mean	Std. Deviation	Std. Error Mean
How strongly does this smell?	Androstenone	59	1.9492	.93631	.12190
	Placebo	46	2.1739	.87697	.12930

Discussion

Unlike previous studies regarding androstenone detection (Knaapila et al., 2012), our hypothesis regarding the percent of the participant sample capable of detecting androstenone was rejected, as more participants rated detecting a stronger scent from the control than the experimental solution. This result could be due to the androstenone solution utilized for the study, as it may have been rendered nearly scentless as advertised.

There was a significant difference in ratings of “enthusiasm” between the experimental and control group. “Enthusiastic” was one of the emotion options presented to the participants on the modified PANAS questionnaire. The condition androstenone reported higher overall enthusiasm than the water condition, though this elevation in enthusiasm was not significantly different between male and female participants. The elevated levels across

both genders could support a general hypothesis for androstenone as a sexual attractant used in chemosignaling (Pause et al., 1999), as females produce low levels of androstenone as well.

A crossover interaction in the analysis displayed that androstenone increased “jitteriness” in males, and decreased “jitteriness” in females. There was a marginally significant interaction between males and increased “irritability” in the androstenone condition, and a reduction of “irritability” in females within the androstenone condition. There was a significant interaction that showed males responding over all more negatively under the androstenone condition due to the increased levels of “irritation,” “hostility,” and “jitteriness” than females, supporting the findings of Lubke & Pause (2014).

Potential problems with the experiment include incomplete report forms that resulted in the loss of several data points, and the quality of the androstenone solution. The researchers concluded that the directions for the PANAS questionnaire may not have been clearly explained to all participants as some forms were left nearly blank or were returned with an erroneous symbol in place of the symbol used to identify their condition. The androstenone solution was chosen based on internet reviews, manufacturer claim of purity and strength, and was an accessible resource, but the quality or amount of androstenone hormone in the solution cannot be verified. As the control group reported a higher detection of scent it is likely that the expectation of a scent produced a demand effect in the data and must be taken into consideration with the analysis.

Further research into the capacity for humans to detect the scent of androstenone at a physiological level would prove beneficial to its hypothesized function as a sexual attractant, as this ability is still controversial. Androstenone is often advertised and sold for the purpose of attracting a poten-

tial sexual partner; though there is a lack of chotomy. investigation regarding sexual attractions that lie beyond a heterosexual gender di-

References

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Table 1

Scent Detection

Group Statistics

	Androstenone or placebo	N	Mean	Std. Deviation	Std. Error Mean
How strongly does this smell?	Androstenone	59	1.9492	.93631	.12190
	Placebo	46	2.1739	.87697	.12930

Table 2

Scent Detection

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
How strongly does this smell?	Equal variances assumed	.074	.786	-1.255	103	.212	-.22476	.17916	-.58008	.13056
	Equal variances not assumed			-1.265	99.534	.209	-.22476	.17770	-.57734	.12782

Table 3. The table below shows the androstenone and placebo conditions in accordance to each type of effect.

Group Statistics

	Androstenone or placebo	N	Mean	Std. Deviation	Std. Error Mean
Interested	Androstenone	58	2.4828	1.12766	.14807
	Placebo	43	2.5581	1.25930	.19204
Distressed	Androstenone	58	1.4655	.86279	.11329
	Placebo	43	1.5814	.82325	.12554
Aroused	Androstenone	58	1.1379	.47566	.06246
	Placebo	43	1.1628	.53141	.08104
Content	Androstenone	56	2.7679	1.20591	.16115
	Placebo	43	2.4419	1.35053	.20595
Guilty	Androstenone	58	1.0690	.31690	.04161
	Placebo	43	1.1163	.44771	.06827
Hostile	Androstenone	58	1.1897	.66112	.08681
	Placebo	43	1.3023	.74113	.11302
Irritable	Androstenone	58	1.4138	.85910	.11281
	Placebo	43	1.4651	.98437	.15012
Alert	Androstenone	58	2.1552	1.21109	.15902
	Placebo	42	2.0952	1.20587	.18607
Jittery	Androstenone	58	1.5172	.97767	.12837
	Placebo	43	1.6977	1.12408	.17142
Enthusiastic	Androstenone	58	2.3793	1.24008	.16283
	Placebo	43	1.7442	1.00221	.15284

Table 4. As seen in the table below, enthusiasm was the only significant condition.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Interested	Equal variances assumed	.801	.373	-.316	99	.753	-.07538	.23853	-.54867	.39791
	Equal variances not assumed			-.311	84.719	.757	-.07538	.24250	-.55755	.40679
Distressed	Equal variances assumed	.353	.554	-.680	99	.498	-.11588	.17030	-.45378	.22203
	Equal variances not assumed			-.685	92.874	.495	-.11588	.16910	-.45169	.21993
Aroused	Equal variances assumed	.264	.609	-.247	99	.805	-.02486	.10063	-.22454	.17482
	Equal variances not assumed			-.243	84.696	.809	-.02486	.10231	-.22830	.17858
Content	Equal variances assumed	2.705	.103	1.265	97	.209	.32600	.25762	-.18531	.83730
	Equal variances not assumed			1.247	84.875	.216	.32600	.26151	-.19396	.84595
Guilty	Equal variances assumed	1.606	.208	-.622	99	.535	-.04731	.07606	-.19823	.10361
	Equal variances not assumed			-.592	71.706	.556	-.04731	.07996	-.20671	.11209
Hostile	Equal variances assumed	1.832	.179	-.804	99	.423	-.11267	.14010	-.39066	.16532
	Equal variances not assumed			-.791	84.502	.431	-.11267	.14251	-.39605	.17071
Irritable	Equal variances assumed	.774	.381	-.279	99	.781	-.05132	.18400	-.41642	.31378
	Equal variances not assumed			-.273	83.263	.785	-.05132	.18778	-.42478	.32214
Alert	Equal variances assumed	.200	.656	.245	98	.807	.05993	.24494	-.42613	.54600
	Equal variances not assumed			.245	88.721	.807	.05993	.24477	-.42643	.54630
Jittery	Equal variances assumed	1.293	.258	-.860	99	.392	-.18043	.20975	-.59663	.23576
	Equal variances not assumed			-.843	83.068	.402	-.18043	.21416	-.60639	.24552
Enthusiastic	Equal variances assumed	3.340	.071	2.756	99	.007	.63512	.23046	.17784	1.09241
	Equal variances not assumed			2.844	98.217	.005	.63512	.22332	.19196	1.07829

Table 5

*Reported Levels of Enthusiasm Among Gender***Between-Subjects Factors**

		Value Label	N
Androstenone or placebo	1.00	Androstenone	58
	2.00	Placebo	42
Gender	1.00	Female	65
	2.00	Male	35

Table 6

Tests of Between-Subjects Effects

Dependent Variable: Enthusiastic

Source	Type III Sum of Squares	df
Corrected Model	12.058 ^a	3
Intercept	372.508	1
Condition	10.354	1
Gender	.478	1
Condition * Gender	.000	1
Error	124.132	96
Total	573.000	100
Corrected Total	136.190	99

R Squared = .089 (Adjusted R Squared = .060)

Table 7

Reported Levels of Jitteriness Among Gender

Between-Subjects Factors			
	Value	Label	N
Androstenone or placebo	1.00	Androstenone	58
	2.00	Placebo	42
Gender	1.00	Female	65
	2.00	Male	35

Table 8

Tests of Between-Subjects Effects

Dependent Variable: Jittery

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10.994 ^a	3	3.665	3.689	.015
Intercept	230.850	1	230.850	232.386	.000
Condition	.014	1	.014	.014	.907
Gender	1.237	1	1.237	1.246	.267
Condition * Gender	7.771	1	7.771	7.822	.006
Error	95.366	96	.993		
Total	356.000	100			
Corrected Total	106.360	99			

a. R Squared = .103 (Adjusted R Squared = .075)

Table 9

*Reported Levels of Irritability Among Gender***Between-Subjects Factors**

		Value Label	N
Androstenone or placebo	1.00	Androstenone	58
	2.00	Placebo	42
Gender	1.00	Female	65
	2.00	Male	35

Table 10

Tests of Between-Subjects Effects

Dependent Variable: Irritable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.962 ^a	3	.987	1.189	.318
Intercept	184.672	1	184.672	222.502	.000
Condition	.035	1	.035	.042	.838
Gender	.067	1	.067	.081	.776
Condition * Gender	2.559	1	2.559	3.084	.082
Error	79.678	96	.830		
Total	290.000	100			
Corrected Total	82.640	99			

a. R Squared = .036 (Adjusted R Squared = .006)

Table 11

Reported Levels of Hostility Among Gender

Between-Subjects Factors			
		Value Label	N
Androstenone or placebo	1.00	Androstenone	58
	2.00	Placebo	42
Gender	1.00	Female	65
	2.00	Male	35

Table 12

Tests of Between-Subjects Effects

Dependent Variable: Hostile

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.241 ^a	3	.747	1.559	.204
Intercept	142.505	1	142.505	297.407	.000
Condition	.085	1	.085	.178	.674
Gender	.631	1	.631	1.318	.254
Condition * Gender	.926	1	.926	1.932	.168
Error	45.999	96	.479		
Total	202.000	100			
Corrected Total	48.240	99			

a. R Squared = .046 (Adjusted R Squared = .017)

Table 13

Between-Subjects Factors

		Value Label	N
Androstenone or placebo	1.00	Androstenone	56
	2.00	Placebo	41
Gender	1.00	Female	62
	2.00	Male	35

Table 14

Tests of Between-Subjects Effects

Dependent Variable: POSITIVE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.643 ^a	3	.548	.955	.417
Intercept	372.568	1	372.568	649.778	.000
Condition	1.469	1	1.469	2.562	.113
Gender	.004	1	.004	.007	.932
Condition * Gender	.545	1	.545	.951	.332
Error	53.324	93	.573		
Total	480.640	97			
Corrected Total	54.967	96			

Table 15

Between-Subjects Factors

		Value Label	N
Androstenone or placebo	1.00	Androstenone	58
	2.00	Placebo	42
Gender	1.00	Female	65
	2.00	Male	35

Table 16

Tests of Between-Subjects Effects

Dependent Variable: NEGATIVE

Source	Type III Sum of Squares	df	Mean Square
Corrected Model	1.747 ^a	3	.582
Intercept	169.414	1	169.414
Condition	.014	1	.014
Gender	.167	1	.167
Condition * Gender	1.164	1	1.164
Error	22.523	96	.235
Total	211.960	100	
Corrected Total	24.270	99	

a. R Squared = .072 (Adjusted R Squared = .043)

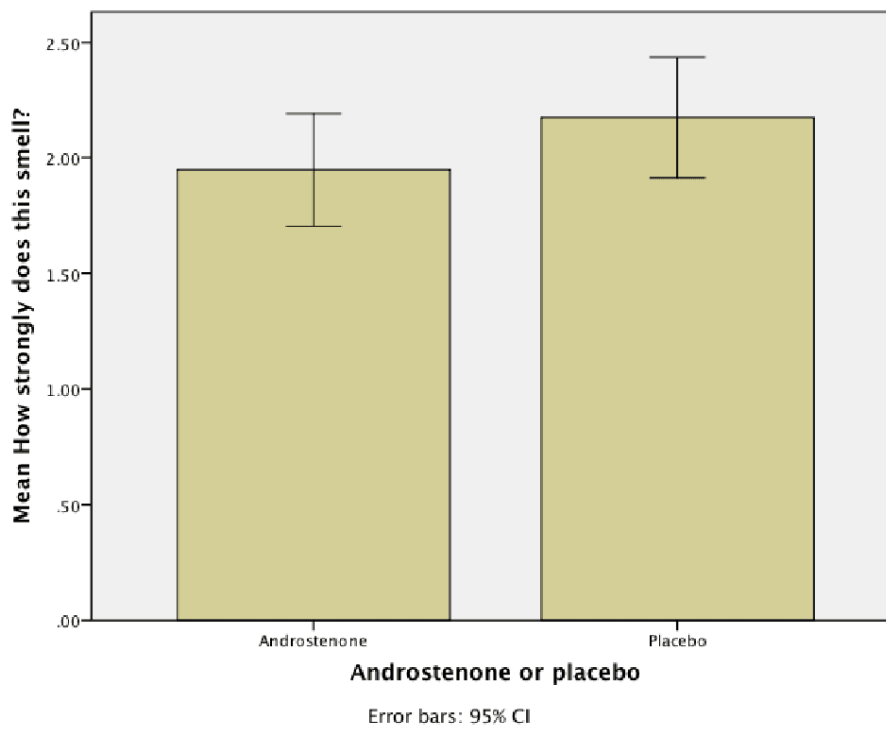


Figure 1. Difference in strength between perceived scent between participants in those that smelled the androstenone and those who smelled the placebo. Participants reported the placebo smell to be slightly more present than the androstenone smell, which they could not smell on average.

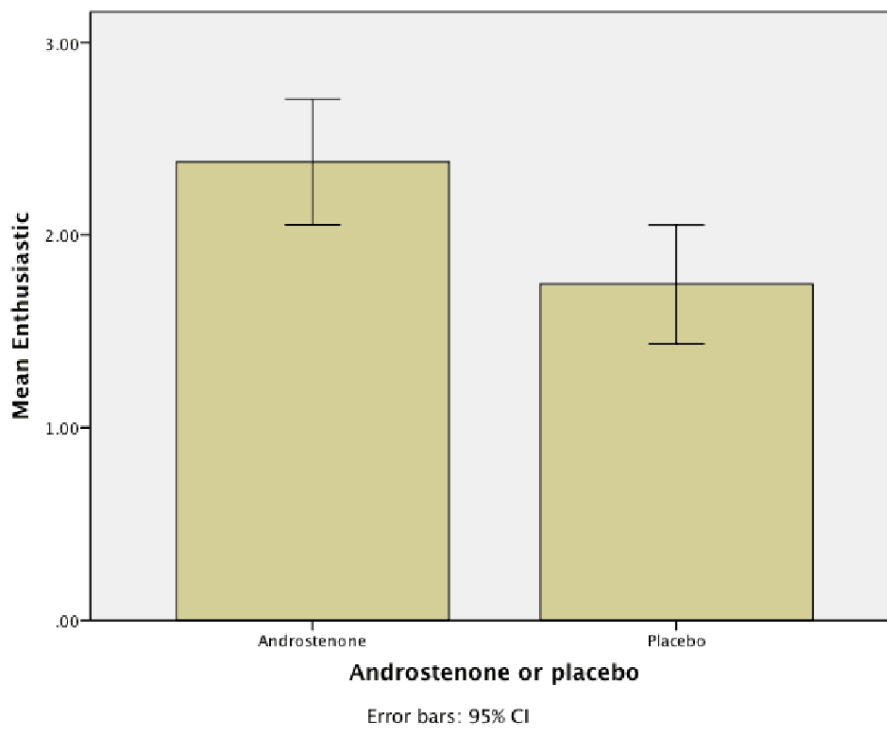


Figure 2. Participants in the androstenone condition reported significantly higher levels of enthusiasm than the participants in the placebo group.

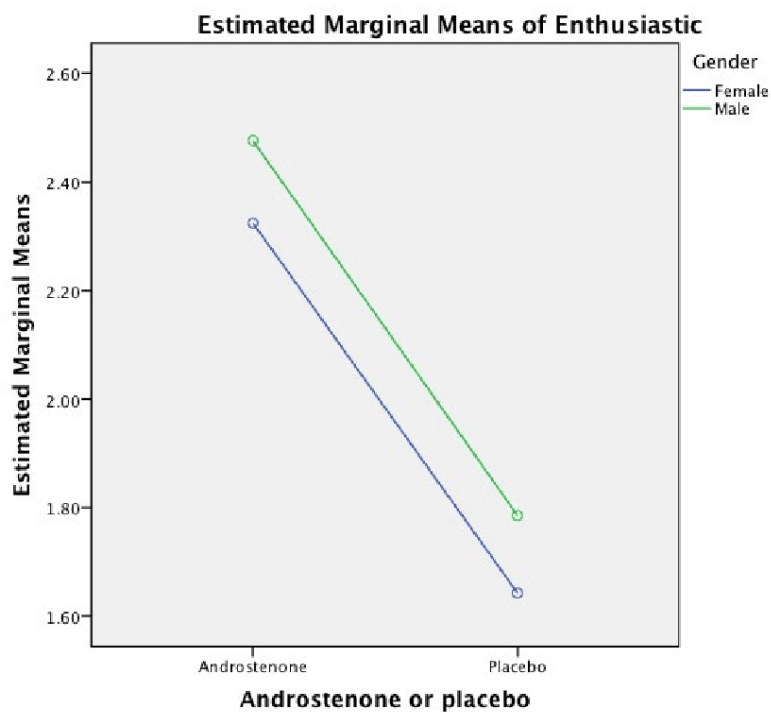


Figure 3. Males and female participants in the androstenone condition reported higher levels of enthusiasm compared to the placebo condition. There was no significant difference between men and women on enthusiasm.

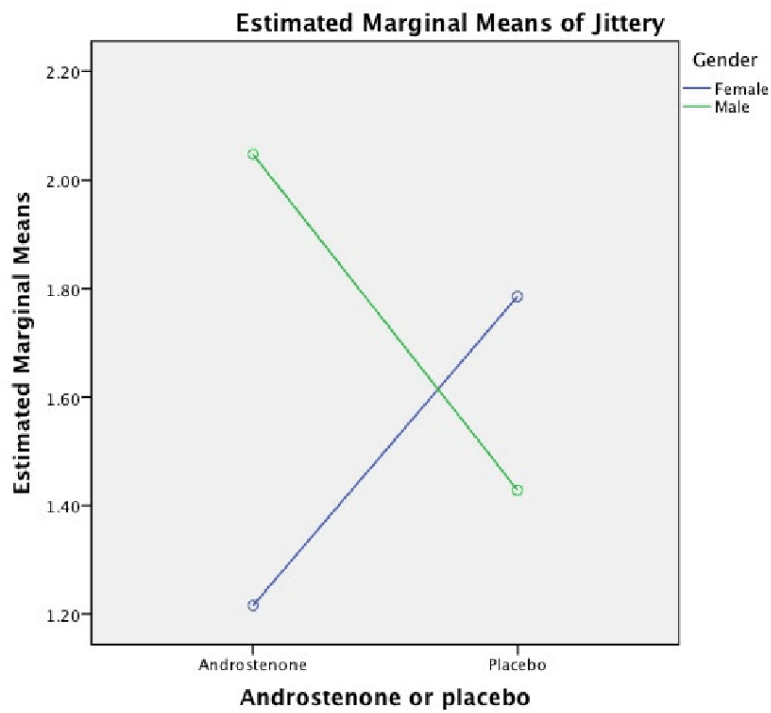


Figure 4. There was a significant interaction between the androstenone condition and jitteriness across gender. Male participants reported to feel more jittery than female participants in the androstenone condition. Females seemed to be more calm after being exposed to androstenone. In the placebo group, females were more jittery than males.

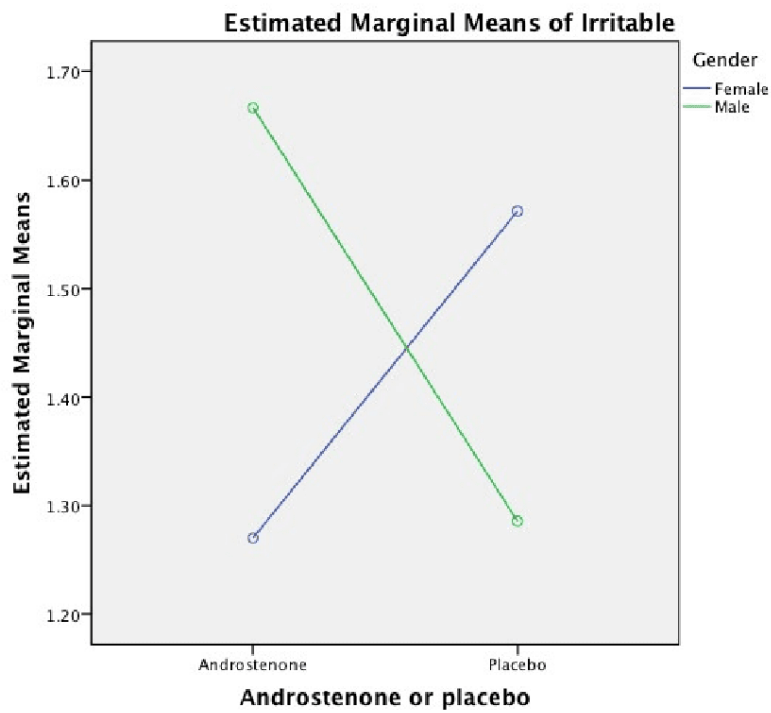


Figure 5. There was a marginally significant interaction between irritability level and androstenone condition. Male participants reported to be more irritable in the androstenone condition than females, who reported less irritability. In the placebo condition, males reported less irritability while females reported more.

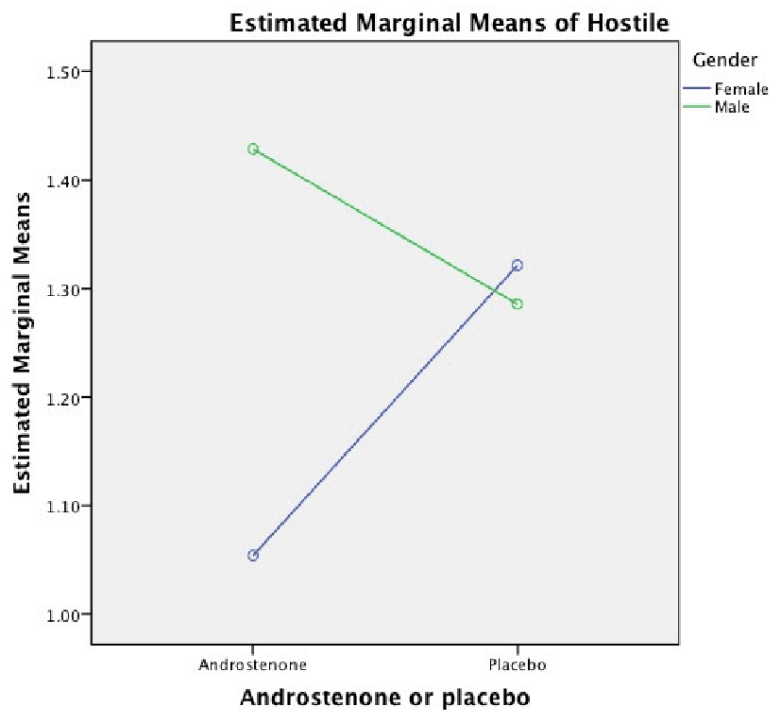


Figure 6. Male participants in the androstenone condition reported more levels of hostility than females in the androstenone condition. In the placebo condition, females reported more hostility than males. There was not a significant interaction between the androstenone condition and hostility, nor was it marginally significant, but it was slightly close to being marginally significant.

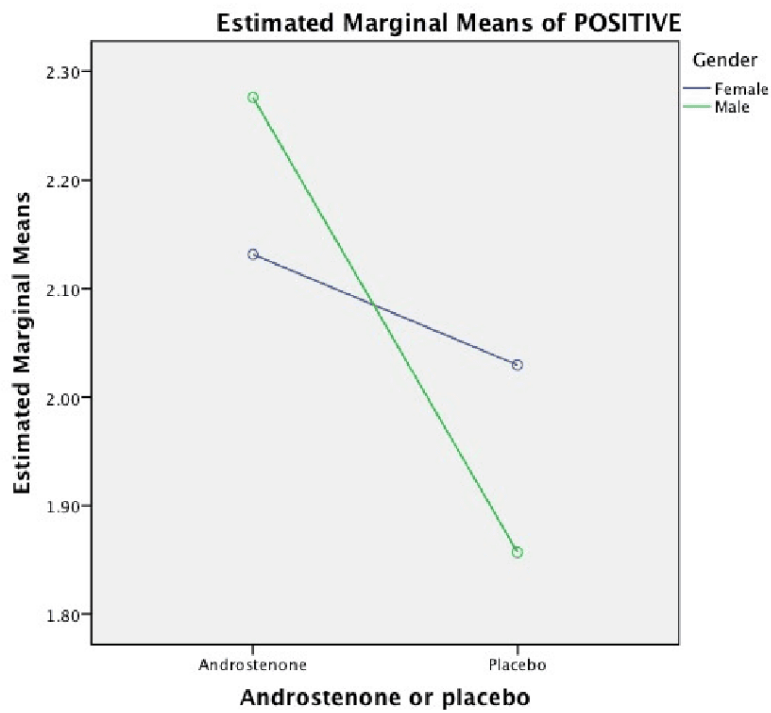


Figure 7. Males were more positive in the androstenone condition than in the placebo condition.

Females were also more positive in the androstenone condition than in the placebo condition.

This can be supported by the significance of enthusiasm.

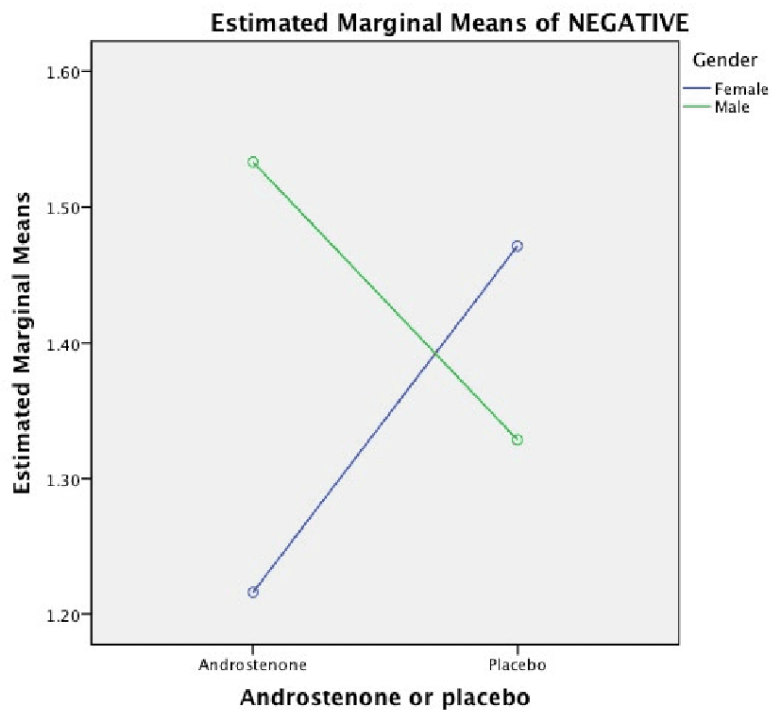


Figure 8. Males were more negative by androstenone in the placebo condition than in the androstenone condition. Females were less negative by androstenone and more negative in the placebo group. This can be due to hostility, irritability, and jitteriness.



Rose Hodson

Rose Hodson is currently an undergraduate psychology major at California State University Stanislaus where she has been enrolled since 2007; she plans to graduate and walk the stage in the Fall of 2014. Rose intends to continue her education and pursue a graduate degree in neuropsychology and has been looking into programs in Austin/San Antonio, where she plans to move after the Fall semester. She is the happy owner of two hound dogs, Monkey and Gryffin, and when she's not voraciously reading young adult dystopian fiction, she enjoys painting with oils and acrylics and trying to hone her photography skills. She is a camping enthusiast and takes advantage of every opportunity to travel. Rose fancies herself a natural diagnostician, and is most intrigued by brain injuries, disorders, and exploring possible rehabilitative therapies. She immigrated to Modesto, California from Hesse, England with her family at the age of three. Rose is the youngest of five and considers herself fortunate enough to "have the best Mum anyone could ask for." Her mother's love, support, and belief in Rose has been a constant reassurance to her. Rose appreciates the opportunity to share her group's experiment in this journal and thanks them as well, for everything.