

## Research

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# Synthetic Hormone Dose in Hormonal Contraceptives Predicts Individual Differences in Personality

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## ABSTRACT

The purpose of this study is to investigate whether the dose of synthetic hormones in hormonal contraceptives (HCs) is related to between-subject variation in personality. HC users reported the brand of their HC and completed the Big Five Inventory (BFI). Each woman's dose of synthetic hormones was calculated and a median split assigned women to the high or low synthetic estrogen group and the high or low synthetic progesterone group. Women taking HCs high in synthetic estrogen scored lower on extraversion and higher on neuroticism than those taking HCs relatively low in synthetic estrogen. There were no effects of synthetic progesterone level on any of the Big Five personality traits. Results suggest that synthetic estrogen in HCs may influence women's personality. Future research should investigate this possibility experimentally or using a pre-post design, and should investigate anatomical neural correlates.

**KEYWORDS:** Contraception; Hormones; Estrogen; Progesterone; Personality; Extraversion; Neuroticism.

**ABBREVIATIONS:** HCs: Hormonal contraceptives; BFI: Big Five Inventory; ANCOVA: Analysis of covariance.

## INTRODUCTION

Although the physical side effects of hormonal contraceptives (HCs) are well-established,<sup>1</sup> researchers have only recently begun to investigate the psychological and behavioral side effects of HC use. Currently, evidence suggests that synthetic estrogen in HCs may drive changes in women's behavior. Women using HCs experience greater levels of jealousy<sup>2</sup> and higher use of mate retention tactics<sup>3</sup> than other women. This increase in jealousy and mate guarding is associated with the level of synthetic estrogen, but not the level of progestin, in HCs, with women using contraceptives higher in synthetic estrogen reporting greater jealousy and mate guarding than women using other contraceptives. Interestingly, the level of synthetic estrogen in combined HCs also positively predicts women's objectification of other women.<sup>4</sup> Collectively, these findings imply that synthetic estrogen administered *via* HCs changes aspects of women's behavior, which may reflect underlying changes in personality.

The Big Five personality dimensions – extraversion, agreeableness, conscientiousness, openness to experience, and neuroticism – have consistently been identified by personality researchers. Past research has found higher levels of neuroticism (i.e., emotional instability) in women in more egalitarian countries,<sup>5</sup> and women in these countries are more likely to use HCs,<sup>6</sup> which could indicate that differences in personality reflect differences in synthetic hormone exposure. Given that women using HCs experience greater levels of jealousy, an emotion associated with neuroticism,<sup>7</sup> than naturally-cycling women,<sup>2</sup> and that the level of synthetic estrogen within HCs predict jealousy and mate guarding,<sup>2,8</sup> it is likely that synthetic estrogen influences women's personality. Indeed, when combined with low extraversion, high neuroticism predicts negative interpretations of objective life events<sup>9</sup> and low subjective well-being.<sup>10</sup>

which, if related to HC use, may partially explain increased incidence of negative affect and depression among contraceptive users.<sup>1</sup> Therefore, the current study investigates differences in personality as a function of synthetic hormone dosage among women using HCs. It is predicted that synthetic estrogen level will predict women's personality traits, particularly neuroticism and extraversion.

## METHODS

### Participants

One hundred and fifty-four women (Age:  $M=29.37$  years,  $SD=5.66$ , range=18-40) who reported currently using HCs participated in this study. All but 10 were Caucasian (1=Asian Indian, 3=Asian, 2 Filipino, 4=unspecified or biracial), 27 were single, and none were currently pregnant. Informed consent was obtained from all individual participants included in the study.

### Procedure

Participants reported their sex, age, ethnicity, relationship status, the brand of HC they use, their use of other hormonal supplements, and the date their last child was born (if applicable). No participants reported any use of other hormone supplements within the last 3 months and none had given birth within the last 6 months. Next, participants completed the Big Five Inventory 44-item personality inventory (BFI-44).<sup>11</sup> The BFI-44 is a self-administered personality test that measures the broad-level Big Five personality traits. It contains 44 statements that are each measured on a 5-point Likert scale (anchors: 1=strongly disagree, 5=strongly agree), shows high test-retest reliability, and correlates strongly with other personality scales.<sup>11</sup> High scores on any of the 5 measured personality traits indicate a high tendency toward that particular trait. Testing was conducted online.

### Initial Processing of Data

Following previous work,<sup>2,8</sup> the exact doses of synthetic estrogen and progesterone were determined for each participant (averages were used for multiphasic contraceptives). Participants were separated into a high and a low synthetic estrogen group and a high and a low synthetic progesterone group using a median split. With the exception of one participant taking a HC that is exceptionally high in synthetic estrogen (*Zoely*: 1.5 mg), synthetic estrogen dose ranged from 0  $\mu\text{g}$  (e.g., *Ortho Micronor*) to 35  $\mu\text{g}$  (e.g., *Necon*). Excluding this participant did not alter the findings. Synthetic progesterone dose ranged from 14  $\mu\text{g}$  (*Skyla*) to 150 mg (*Depo Provera*). The levels of synthetic estrogen and progesterone were not correlated ( $r_{154}=-.031$ ,  $p=.70$ ).

Kolmogorov-Smirnov tests showed that all traits on the BFI (all  $D_{154}>.078$ , all  $p<.022$ ) except neuroticism ( $D_{154}=.061$ ,  $p=.2$ ) were significantly non-normal, hence non-parametric Mann-Whitney U-tests were used. However, the results below are equivalent to those obtained using independent samples  $t$ -

tests. All statistics are two-tailed.

## RESULTS

There were significant differences between women in the high versus low estrogen groups in extraversion ( $U=2183.5$ ,  $Z=2.699$ ,  $p=.007$ ,  $r=0.23$ ) and neuroticism ( $U=2355.5$ ,  $Z=2.073$ ,  $p=.038$ ,  $r=0.17$ ), whereby extraversion was lower ( $M=23.71$ ,  $SD=.64$ ) and neuroticism was higher ( $M=24.21$ ,  $SD=.52$ ) for women in the high estrogen group than in the low estrogen group (extraversion:  $M=26.05$ ,  $SD=.55$ ; neuroticism:  $M=22.48$ ,  $SD=.57$ ). There were no other significant effects of synthetic estrogen and there were no effects of synthetic progesterone level on any personality trait (all  $p>.36$ ).

Next, a univariate Analysis of covariance (ANCOVA) (dependent variable: extraversion; fixed factors: hormone dose [low estrogen, high estrogen]; covariate: neuroticism) revealed a marginally significant main effect of synthetic estrogen ( $F_{1,154}=3.321$ ,  $p=.07$ ), with extraversion being lower in the high synthetic estrogen group than in the low synthetic estrogen group. There was also a main effect of neuroticism ( $F_{1,154}=75.719$ ,  $p<.001$ ), indicating that neuroticism significantly predicts extraversion ( $r=-.593$ ,  $p<.001$ ). A second ANCOVA (dependent variable: neuroticism; fixed factors: hormone dose [low synthetic estrogen, high synthetic estrogen]; covariate: extraversion) revealed no main effect of synthetic estrogen level on neuroticism when controlling for extraversion ( $F_{1,154}=.476$ ,  $p=.49$ ), suggesting that extraversion moderates the effects of synthetic estrogen on neuroticism.

## DISCUSSION

Here, extraversion was lower and neuroticism was higher among women taking HCs higher in synthetic estrogen. Low extraversion and high neuroticism predispose people to experience more negative objective life events<sup>9</sup> and predict low subjective well-being,<sup>10</sup> relationship satisfaction, and intimacy,<sup>12</sup> and high anxiety, depression,<sup>13</sup> and jealousy.<sup>14</sup> Together with other research on HCs,<sup>2-4,8</sup> this suggests that high levels of synthetic estrogen within HCs may negatively impact personality, which may have downstream consequences on intra-couple and other social behaviors. Still, future research should more explicitly test the relationship between synthetic estrogens and happiness, relationship satisfaction, and sexual satisfaction. For instance, Roberts et al.<sup>15</sup> examined the influence of HCs on relationship and sexual satisfaction among women who were versus were not using HCs when they met the father of their first child. HC users reported lower sexual satisfaction and lower partner attraction than non-users. They also reported decreasing sexual satisfaction during the relationship and were more likely than their partner to initiate a separation if it occurred. However, HC users were less likely to separate from their partners overall and reported being more satisfied with their partner's financial provision compared to non-users.<sup>15</sup> Differences or changes in personality between these groups and/or synthetic hormone dose may mediate some

of these findings.

It is possible that the observed HC-related differences in personality may be a direct consequence of neurological alterations brought about by the pill. Recently, Petersen, Touroutoglou, Andreano, and Cahill<sup>16</sup> linked oral contraceptive use with localized decreases in cortical thickness in the lateral orbitofrontal cortex and the posterior cingulate cortex. These brain regions are believed to be involved in emotion regulation and the evaluation of internal states, respectively,<sup>16</sup> and have been linked to between-subjects differences in personality.<sup>17</sup> When taken with the results of the current study, it is possible that the synthetic estrogen found in combined HCs may act to decrease the cortical thickness of these brain regions, which may in turn cause associated changes in extraversion, neuroticism, and other associated behaviors. Although highly speculative, future research should investigate this possibility.

Additional analysis revealed a near-significant trend whereby extraversion was lower in the high estrogen group when controlling for differences in neuroticism. This main effect likely fell just short of significance due to a loss of power because synthetic hormone dose could not be randomized across participants.<sup>18</sup> There were no equivalent effects of synthetic estrogen level on neuroticism when controlling for extraversion, indicating that extraversion may moderate the effects of synthetic estrogen on neuroticism. However, extraversion negatively predicts neuroticism, suggesting that introversion often presents with high neuroticism in the current sample, which may be indicative of differences in self-esteem between the high *versus* low estrogen groups. Indeed, self-esteem is characterized by low extraversion and high neuroticism.<sup>19</sup> Alternatively, synthetic estrogen may decrease women's social dominance. Extraversion is characterized by social ability,<sup>20</sup> and is positively related to social status<sup>21</sup> and social dominance/leadership.<sup>22</sup> Thus, the current findings suggest that synthetic estrogen may decrease a woman's social dominance, social status, and/or related constructs, which could negatively impact aspects of patient well-being. (e.g., stress, health).<sup>23</sup> However, this hypothesis is also highly speculative and more direct investigations of the relationships between dose of synthetic hormones in combined HCs and self-esteem, social dominance, social ability, and subjective well-being are warranted.

## CONCLUSIONS

The current study used a nonexperimental between-subjects design. Therefore, it remains a possibility that unknown individual differences are confounding the results. Future research should examine these variables using a pre-post design in order to better gauge changes in personality before *versus* after initiating HC use. Alternatively, scholars could experimentally manipulate synthetic hormone dose, preferably using a within-subjects design, to better investigate cause-and-effect relationships between synthetic hormones and personality traits. Researchers should also investigate the relationship between HC-related personal-

ity changes and neurological alterations like those observed by Petersen et al.<sup>16</sup> as well as other associated behaviors. Nonetheless, this study adds to the existing literature on the effects of synthetic hormones on human behavior and opens up exciting avenues for additional enquiry.

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