



Short Communication

No personality differences between oral contraceptive users and naturally cycling women: Implications for research on sex hormones

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ABSTRACT

Oral contraceptives (OCs) are the most widely used contraception method, and there is increasing interest in their effects on cognition, affect, and brain structure and function. Since women are not randomly assigned to OC use or non-use, it is unclear if previously-reported differences between OC users and naturally cycling (NC) women are due to sex hormones or to personal characteristics associated with pill use. The aim of this study was to fill this knowledge gap by comparing OC users and NC women on the Big Five personality factors. Participants came from two independent, large samples. The first contained 148 OC users and 93 NC women, and the second contained 247 OC users and 148 NC women. Consistent across both samples, multivariate analyses of covariance (with the five personality factors as dependent variables and age as a covariate) revealed no significant differences between OC users and NC women in personality, with absolute values of univariate effect sizes averaging $d = .09$. The pattern of results did not change when reason for OC use was considered, and users of different types of OCs did not differ from each other in personality. This well-powered study did not find personality differences between OC users and NC women in two independent samples, suggesting that previously-reported differences in cognition, affect, and the brain may be linked to neuroendocrinology.

1. Introduction

Nearly 10 million women in the United States take oral contraceptives (OCs) – the most widely-used contraception method in the world (Daniels et al., 2015). Biomedical and social scientists, practitioners, and users are increasingly interested in the psychological consequences of “the pill.” This is evidenced in research on the cognitive, affective, and neural correlates of OC use, with many studies comparing OC users and non-users or naturally cycling (NC) women on outcomes.

In these comparisons, psychological effects of OC use have been found. OC users have been shown to outperform non-users in verbal memory and attention (Gogos, 2013; Kuhlmann and Wolf, 2005), and some have been reported to have better spatial skills, particularly in mental rotations tasks (Beltz et al., 2015). OC users generally show less variability in mood than NC women, and they have different patterns of affect and risk for depression (Hamstra et al., 2017; Keyes et al., 2013). There are also OC-NC structural differences in frontal and temporal regions of the brain and functional differences during face processing and cognitive tasks (Pletzer et al., 2015).

OC-NC differences, however, are not always found, and an oft-cited concern is that participants are not randomly assigned to OC use or non-use (Gogos et al., 2014; Warren et al., 2014). It is possible that

previously-reported differences do not reflect neuroendocrine effects, but rather individual differences in personal characteristics related to pill use. This would limit generalizability, accentuating problems associated with the small sample sizes often employed in OC research (Warren et al., 2014).

Several lines of evidence argue against personal characteristics as an alternative explanation for OC-NC group differences. One shows that differences depend upon the pharmacokinetic properties of the pills. For instance, different generations of progestins have different androgenic activity and differentially relate to androgen-associated processes: NC women outperform users of anti-androgenic OCs in mental rotations tests, but are, in turn, outperformed by users of moderately androgenic OCs (Beltz et al., 2015; Griksiene et al., 2018). Another line of evidence shows dose-related effects of exogenous hormones, such as linear improvement in mental rotations performance with decreases in ethinyl estradiol dose and OC effects that are modulated by the active versus placebo pill phase (Beltz et al., 2015; Warren et al., 2014).

Despite indirect evidence, there has not been a recent and well-powered empirical response to the criticism that “differences exist between these [OC use and non-use] groups with regard to personality factors” (Warren et al., 2014, p. 114). Some studies suggest that OC users have higher neuroticism than NC women (Ross et al., 2001;

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Schallmayer and Hughes, 2010), but others report no personality differences (Hamstra et al., 2017; Kuhlmann and Wolf, 2005). Regardless, samples are small (averaging 34 women per group in these studies) and sometimes selective (e.g., with only a third providing complete data).

The aim of this study was to examine personality differences between OC users and NC women in two large samples, each with 6-to-10 times the number of OC users than in the average-sized study (Warren et al., 2014). We examined OC-NC group differences in the Big Five personality factors and explored whether differences from NC women depend on the reason for pill use, and whether users of different types of OCs differ in personality.

2. Materials and method

Data come from two samples. Testing procedures and demographics differed, so analyses were conducted separately for each sample, serving as replications. Characteristics of each sample align with those commonly reported in OC research (Gogos et al., 2014).

2.1. Participants

Sample 1 participants were women aged 18–22 years ($M_{age} = 18.98$; $SD_{age} = .79$) recruited from an introductory Psychology subject pool at a large Mid-Atlantic university. The final sample of OC users ($N = 148$) and NC women ($N = 93$) did not differ in age, $t(239) = -0.43$, $p = .667$, race, $\chi^2(4) = 8.61$, $p = .072$, or ethnicity, $\chi^2(1) = 2.36$, $p = .125$. Sample details and cognitive data were previously reported (Beltz et al., 2015).

Sample 2 participants were women aged 18–38 years ($M_{age} = 20.73$; $SD_{age} = 2.68$) recruited from a university community at a large Midwestern university. About half (53.5%) came from an introductory Psychology subject pool; others were recruited from university email blasts, online postings, and campus flyers. The final sample of OC users ($N = 247$) and NC women ($N = 148$) did not differ in age, $t(393) = -0.57$, $p = .567$ or ethnicity, $\chi^2(1) = .01$, $p = .921$, but there were proportionately more self-identified Asian women in the NC (26%) versus the OC (11%) group, $\chi^2(4) = 21.25$, $p < .001$.

The final sample sizes reported above do not include women who were tested, but excluded, for common reasons: 33 women in Sample 1 and 78 in Sample 2 were excluded due to testing complications or hormone-related conditions, including past pregnancy, use of hormonal medications other than OCs, use of OCs for less than 3 months, or having an extremely irregular natural cycle. OC users were classified into homogenous groups based upon the active constituents in their pills (USDHHS, 2018), and NC women had not used hormonal contraceptives for the previous 3 months.

2.2. Procedures

Participants provided informed consent before completing a monitored online survey in a research laboratory. Surveys took 45–60 min to complete. Prior to the survey, OC users confirmed pill use, type, and characteristics through phone screenings (Sample 1) or in-person interviews (Sample 2).

2.3. Measures

Personality was assessed with the NEO Personality Inventory, specifically the Five Factor Inventory-3 (McCrae and Costa, 2007). Participants endorsed their agreement to 60 statements on a Likert scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). Composite scores were created for each factor (Neuroticism, Extroversion, Openness, Agreeableness, Conscientiousness) by taking the average of 12 items. The NEO is widely-used, valid and reliable, and factor internal consistency in the present study was $\alpha = 0.72$ – 0.87 for Sample 1 and $\alpha = 0.75$ – 0.85 for Sample 2.

Personality changes in late adolescence and early adulthood (Roberts and Mroczek, 2008), so age was a covariate in inferential analyses.

2.4. Analysis plan

For each sample, a multivariate analysis of covariance (MANCOVA) was used to examine OC-NC group differences in composite personality (five factors were dependent variables), with age a covariate. Planned follow-up ANCOVAs were conducted to examine group differences on each factor separately. Type I error was .05 for the MANCOVAs, but .01 for the ANCOVAs to correct for multiple comparisons.

A MANCOVA power analysis (in G*Power; Faul et al., 2007) with $\alpha = 0.05$ and power = 0.80, with 2 groups and 5 response variables indicated Sample 1 could detect effects small-to-medium in size ($\eta^2_{\text{partial}} \approx .05$), and Sample 2 could detect small effects ($\eta^2_{\text{partial}} \approx .03$).

Two exploratory analyses were conducted. First, MANCOVAs were repeated including only OC users who were using pills for contraceptive (Sample 1: $N = 83$; Sample 2: $N = 178$) and for non-contraceptive purposes (Sample 1: $N = 33$; Sample 2: $N = 69$). In Sample 1, 32 women did not report a reason for use, and were not included in analyses.

Second, personality differences among homogenous groups of OC users (with $N_s > 40$) were examined using MANCOVAs. In Sample 1, users of monophasic pills containing ethinyl estradiol and norethindrone acetate ($N = 55$) were compared to users of triphasic pills containing ethinyl estradiol and norgestimate ($N = 43$). The same groups were compared in Sample 2 ($N_s = 83$ and 61, respectively) along with users of monophasic pills containing ethinyl estradiol and drospirenone ($N = 51$). Combined OCs that contain norethindrone acetate have more androgenic activity than those containing norgestimate, while drospirenone is an anti-androgenic progestin (Dickey, 2002). Age was a covariate, and Type I error was .05 for exploratory analyses.

3. Results

Sample 1 revealed no overall OC-NC differences in personality, $Wilks' \Lambda = .97$, $F(5, 234) = 1.35$, $p = .244$, $\eta^2_{\text{partial}} = .028$, but age was a significant covariate, $Wilks' \Lambda = .95$, $F(5, 234) = 2.58$, $p = .027$, $\eta^2_{\text{partial}} = .052$. Furthermore, no significant group differences were revealed in follow-up analyses considering each personality factor separately (all p 's $> .067$).

Similar results were found in Sample 2. There were no overall OC-NC differences in personality, $Wilks' \Lambda = .99$, $F(5, 388) = 0.49$, $p = .787$, $\eta^2_{\text{partial}} = .006$, with age a significant covariate, $Wilks' \Lambda = .93$, $F(5, 388) = 6.05$, $p < .001$, $\eta^2_{\text{partial}} = .072$. There were also no significant group differences in univariate follow-up analyses (all p 's $> .275$). Group means, standard deviations, and effect sizes of univariate comparisons are shown in Fig. 1A for Sample 1 and Fig. 1B for Sample 2.

In exploratory analyses, the pattern of results for OC-NC group differences in personality did not change when reason for pill use was considered. In Sample 1 and 2, respectively, neither women using the pill for contraceptive, $Wilks' \Lambda = .96$, $F(5, 169) = 1.27$, $p = .279$, $\eta^2_{\text{partial}} = .036$ and $Wilks' \Lambda = .98$, $F(5, 319) = 1.08$, $p = .370$, $\eta^2_{\text{partial}} = .017$, nor non-contraceptive purposes, $Wilks' \Lambda = .93$, $F(5, 119) = 1.74$, $p = .130$, $\eta^2_{\text{partial}} = .068$ and $Wilks' \Lambda = 1.00$, $F(5, 210) = 0.22$, $p = .955$, $\eta^2_{\text{partial}} = .005$, differed from NC women.

Homogeneous groups of OC users also did not differ from each other in overall personality in Sample 1, $Wilks' \Lambda = .96$, $F(5, 91) = 0.76$, $p = .579$, $\eta^2_{\text{partial}} = .040$, or Sample 2, $Wilks' \Lambda = .96$, $F(10, 374) = 0.83$, $p = .600$, $\eta^2_{\text{partial}} = .022$. Group means, standard deviations, and effect sizes of univariate comparisons are shown in Fig. 2 for the larger Sample 2.

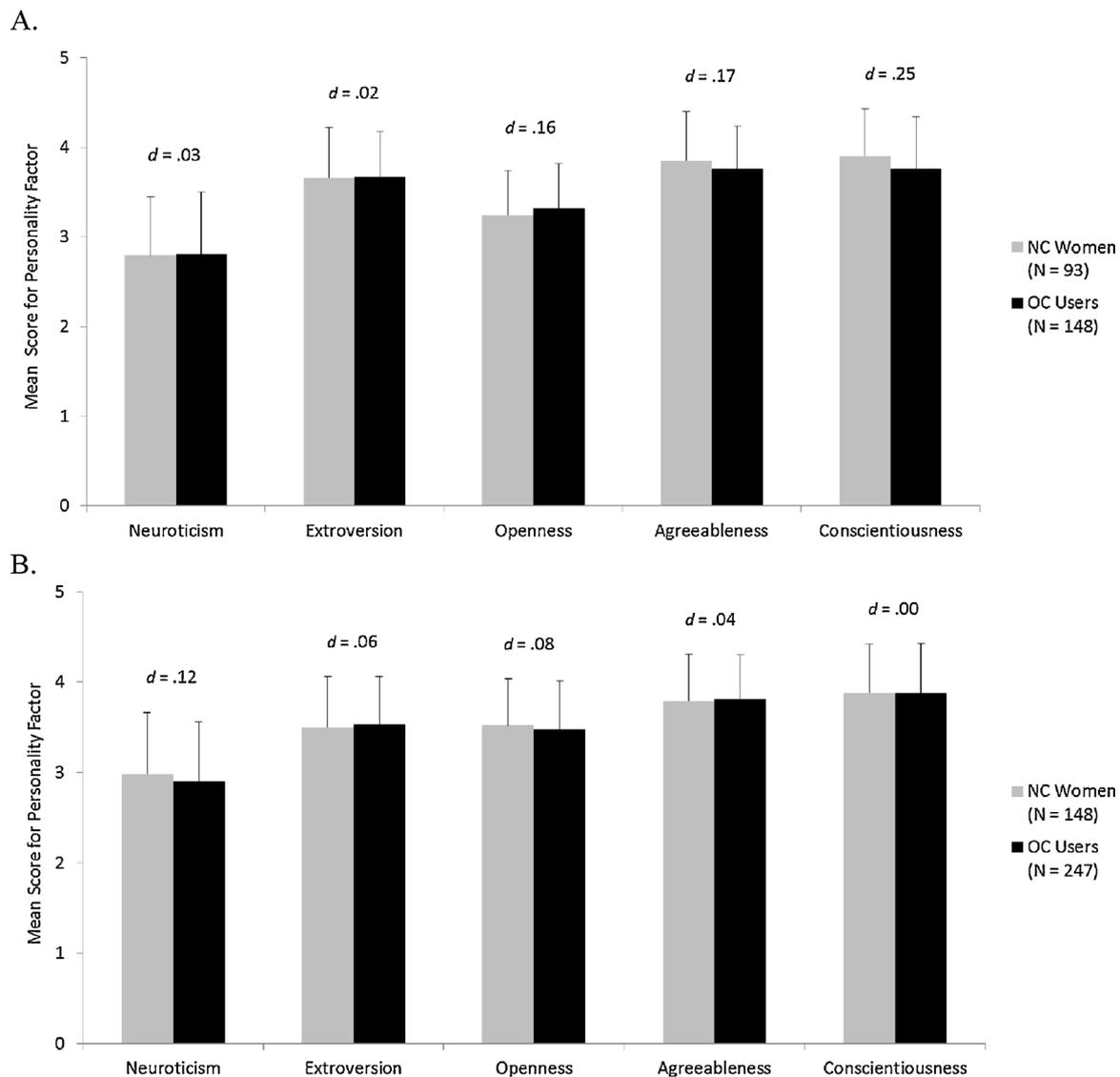


Fig. 1. Mean Big Five personality factor scores for naturally cycling (NC) women and oral contraceptive (OC) users, showing no group differences in two large, independent samples. A.) Results from Sample 1; B.) Results from Sample 2. Error bars reflect standard deviations, and Cohen's *d*'s are absolute values of effect sizes.

4. Discussion and conclusion

Millions of women use OCs, and by comparing users to NC women, emerging yet compelling research shows that “the pill” influences cognition, affect, and the brain, but it is unclear if pre-existing differences in personal characteristics confound effects.

Study results were clear regarding personality. There were no significant differences in Big Five personality factors between OC users and NC women in either sample. Effect sizes for group differences on each personality factor were very small (except for Conscientiousness, which was small in Sample 1, but 0 in Sample 2). The pattern of results did not change when reasons for OC use were considered, and users of different pill types did not differ from each other in personality, suggesting that the lack of differences is not due to heterogeneity among users.

Findings are consistent with smaller studies (Hamstra et al., 2017; Kuhlmann and Wolf, 2005), but inconsistent with those that reported higher neuroticism in OC users than in NC women (Ross et al., 2001; Schallmayer and Hughes, 2010). Reasons for the discrepant findings are related to power and selectivity. Regarding power, across both samples, this study was over 16 times the size of the average sample of OC users (Warren et al., 2014) and had power to detect small effects. So, if OC-

NC differences actually do exist, then they are arguably negligible. Regarding selectivity, this study employed samples that are common in OC research – women from university communities with an average age of 21 years (Gogos et al., 2014). Nonetheless, the majority of participants were recruited from department subject pools and all age groups, races, and ethnicities were not equally represented in the data, so future research should employ diverse samples.

Because the goal of this study was to determine whether different “types” of women are likely to use OCs – not whether sex hormones affect personality – phase was not considered. Although there is little evidence from within-person studies of phase-linked personality change (Kuhlmann and Wolf, 2005) and participants with hormone-related medication use or medical conditions were excluded, OC users were tested in different pill phases (i.e., active and placebo), and menstrual phase in NC women was not controlled. Also, among NC women, history of hormonal contraceptive use beyond three months was unknown.

In conclusion, consistent across two independent, well-powered samples, study results indicate that OC users and non-users do not differ in personal characteristics, specifically the Big Five personality factors. This finding minimizes the concern that previously-reported OC-NC differences in cognition, affect, and the brain were merely the by-product of non-random assignment to OC use. It implies that those

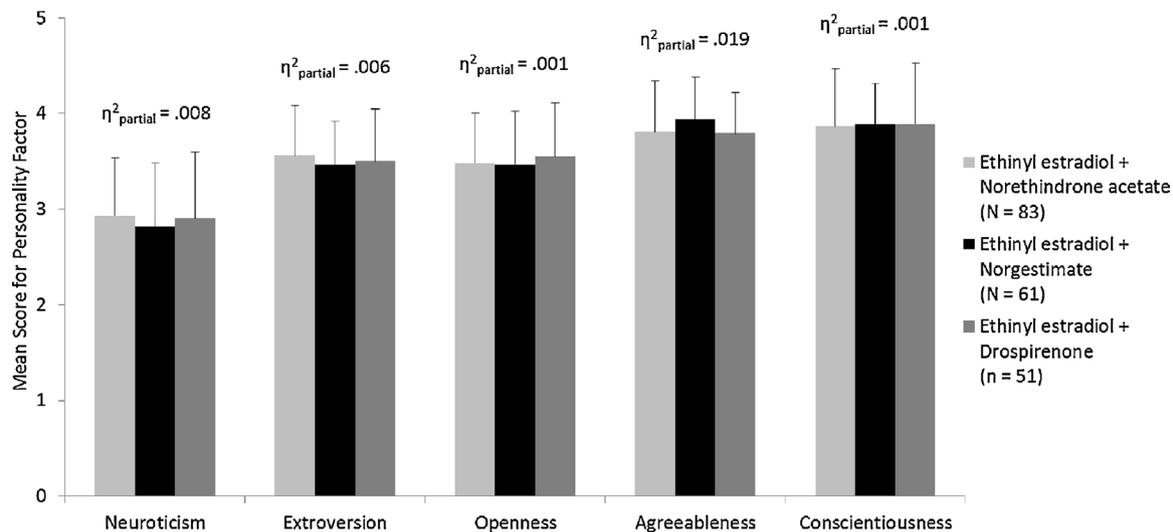


Fig. 2. Mean Big Five personality factor scores for homogenous groups of oral contraceptive users, showing no group differences in Sample 2. Findings were similar for Sample 1. Homogeneous groups with more than 40 users were included in analyses. Pills containing norethindrone acetate were monophasic and have more androgenic activity than those containing norgestimate (which were triphasic), while pills containing drospirenone were monophasic and have no androgenic activity. Error bars reflect standard deviations, and η^2_{partial} are effect sizes.

differences are likely linked to neuroendocrinology, and that OC research is a valuable method for studying sex hormone contributions to psychological processes.

Declaration of interest statement

None.

Author statement

Adriene M. Beltz: Conceptualization; Formal analysis; Methodology; Project administration; Supervision; Visualization; Writing - original draft

Amy M. Loviska: Data curation; Methodology; Writing - review & editing

Dominic Kelly: Methodology; Writing - review & editing

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References

- Beltz, A.M., Hampson, E., Berenbaum, S.A., 2015. Oral contraceptives and cognition: A role for ethinyl estradiol. *Horm. Behav.* 74, 209–217. <https://doi.org/10.1016/j.yhbeh.2015.06.012>.
- Daniels, K., Daugherty, J., Jones, J., Mosher, W., 2015. Current contraceptive use and variation by selected characteristics among women aged 15–44: United States, 2011–

2013. *Natl. Health Stat. Rep.* (86), 1–14.

Dickey, R.P., 2002. *Managing Contraceptive Pill Patients*, 11th ed. Emis Inc, New Orleans, LA.

Faul, F., Erdfelder, E., Lang, A.G., Buchner, A., 2007. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* 39 (2), 175–191. <https://doi.org/10.3758.bf03193146>.

Gogos, A., 2013. Natural and synthetic sex hormones: Effects on higher-order cognitive function and prepulse inhibition. *Biol. Psychol.* 93 (1), 17–23. <https://doi.org/10.1016/j.biopsycho.2013.02.001>.

Gogos, A., Wu, Y.C., Williams, A.S., Byrne, L.K., 2014. The effects of ethinylestradiol and progestins ("the pill") on cognitive function in pre-menopausal women. *Neurochem. Res.* 39 (12), 2288–2300. <https://doi.org/10.1007/s11064-014-1444-6>.

Griksiene, R., Monciunskaitė, R., Arnatkevičiūtė, A., Ruksenas, O., 2018. Does the use of hormonal contraceptives affect the mental rotation performance? *Horm. Behav.* 100, 29–38. <https://doi.org/10.1016/j.yhbeh.2018.03.004>.

Hamstra, D.A., de Kloet, E.R., de Rover, M., van der Does, W., 2017. Oral contraceptives positively affect mood in healthy PMS-free women: a longitudinal study. *J. Psychosom. Res.* 103, 119–126. <https://doi.org/10.1016/j.jpsychores.2017.10.011>.

Keyes, K.M., Cheslack-Postava, K., Westhoff, C., Heim, C.M., Haloossim, M., Walsh, K., Koenen, K., 2013. Association of hormonal contraceptive use with reduced levels of depressive symptoms: a national study of sexually active women in the United States. *Am. J. Epidemiol.* 178 (9), 1378–1388. <https://doi.org/10.1093/aje/kwt188>.

Kuhlmann, S., Wolf, O.T., 2005. Cortisol and memory retrieval in women: influence of menstrual cycle and oral contraceptives. *Psychopharmacology* 183 (1), 65–71. <https://doi.org/10.1007/s00213-005-0143-z>.

McCrae, R.R., Costa, P.T., 2007. Brief versions of the NEO-PI-3. *J. Individ. Differ.* 28 (3), 116–128. <https://doi.org/10.1027/1614-0001.28.3.116>.

Pletzer, B., Kronbichler, M., Kerschbaum, H., 2015. Differential effects of androgenic and anti-androgenic progestins on fusiform and frontal gray matter volume and face recognition performance. *Brain Res.* 1596, 108–115. <https://doi.org/10.1016/j.brainres.2014.11.025>.

Roberts, B.W., Mroczek, D., 2008. Personality trait change in adulthood. *Curr. Dir. Psychol. Sci.* 17 (1), 31–35. <https://doi.org/10.1111/j.1467-8721.2008.00543.x>.

Ross, C., Coleman, G., Stojanovska, C., 2001. Relationship between the NEO Personality Inventory Revised neuroticism scale and prospectively reported negative affect across the menstrual cycle. *J. Psychosom. Obstet. Gynecol.* 22 (3), 165–176. <https://doi.org/10.3109/01674820109049969>.

Schallmayer, S., Hughes, B.M., 2010. Impact of oral contraception and neuroticism on cardiovascular stress reactivity across the menstrual cycle. *Psychol. Health Med.* 15 (1), 105–115. <https://doi.org/10.1080/13548500903499391>.

USDHHS, 2018. *Approved Drug Products With Therapeutic Equivalence Evaluations*, 38th ed. Food and Drug Administration, Washington, D.C.

Warren, A.M., Gurvich, C., Worsley, R., Kulkarni, J., 2014. A systematic review of the impact of oral contraceptives on cognition. *Contraception* 90 (2), 111–116. <https://doi.org/10.1016/j.contraception.2014.03.015>.