Letter to the Editor

An Evolutionary Approach Offers a Fresh Perspective on the Relationship Between Oral Contraception and Sexual Desire

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Concern about the impact of oral contraceptive (OC) use on women's sexual functioning, particularly lowered sexual desire (or libido), has been expressed for almost as long as OCs have been available. Despite numerous studies over several decades, however, we still do not know the underlying mechanism for negative effects nor can we predict which women will suffer from them (Sanders, Graham, Bass, & Bancroft, 2001). **Comment: Has anyone ever calculated effect sizes for negative effects, etc?**

The research has consistently produced mixed evidence, of two kinds. First, there is mixed evidence across studies: some report negative associations between desire and OC use, others find no effect, and still others report positive effects (for recent reviews, see Burrows, Basha, & Goldstein, 2012; Davis & Castano, 2004; Pastor, Holla, & Chmel, 2013; Schaffir, 2006). Second, within their respective samples, studies also consistently report considerable individual variation in women's experience: relatively large proportions of women experience a marked increase or decrease in desire, with others unaffected (Burrows et al., 2012; Davis & Castano, 2004; Pastor et al., 2013; Schaffir, 2006). For example, in a prospective study, 17% had a higher frequency of sexual thoughts and 39% had a lower frequency, following initiation of OC use (Sanders et al., 2001). The picture is further obscured by wide variation between studies in both methodologies and OC formulations under test, but researchers typically conclude, on the basis of these mixed effects, that the influence of OC use on sexual desire is complex and likely due to multiple psychosocial influences (Burrows et al., 2012; Davis & Castano, 2004; Pastor et al., 2013; Schaffir, 2006). Indeed, the most recent review concluded that "we cannot define a single indicator reliably and clearly characterizing a cause-effect relationship. This is mainly due to the simultaneous and intertwined effects of a variety of complex biological, psychological, social, and multidimensional factors" (Pastor et al., 2013).

While this may be an accurate reflection of the current empirical state of affairs, it is clearly unsatisfactory both to women concerned about possible consequences for their relationships and to healthcare providers who are unclear about what advice to give. Perceived changes in libido and arousal are important contributors to OC switching and discontinuation (Sanders et al., 2001). Understanding the mechanism underpinning these mixed effects is therefore of significant public health concern and this is a matter of global importance. According to the UN report on World Contraceptive Use 2011, 9% of partnered women of reproductive age worldwide report using OC as their main contraceptive method, rising to 18% in some regions. In the United States, 82% of sexually experienced women, aged 18-44 years, had used OC at some stage of their lives (Mosher & Jones, 2010).

Against this background, new perspectives that might help to clarify the issue should be seized upon and scrutinized carefully. The possibilities that modulatory effects on mood or reduced circulating testosterone levels (e.g., through up-regulation of sex hormone binding globulin production) might be responsible for OC-associated change in sexual desire, for example, have been rigorously examined although neither adequately explains the data, at least to date (Pastor et al., 2013; Schaffir, 2006). But another promising perspective, from the interface between psychology and evolutionary biology, has so far been ignored or overlooked (at least judging by its absence in any recent review on the subject) (Burrows et al., 2012; Davis & Castano, 2004; Pastor et al., 2013; Schaffir, 2006). Briefly, this literature demonstrates that women's partner preferences are influenced by OC use, meaning that attraction towards an existing partner changes over time if a woman initiates or discontinues OC use. This literature raises two key contextual issues. First, it is important to draw a clear distinction between general desire and that focused on partners; however, this distinction is absent in almost all previous clinical research. Second, rather than examining links between desire and current OC use, as previous researchers have done, studies also need to take into

account a woman's previous use (i.e., during partner choice) and whether or not it matches her current OC use.

In order to highlight this new perspective to clinical researchers interested in sexual and emotional side-effects of hormonal contraception, we therefore introduce the theoretical background to this body of research, summarize its key findings, describe some novel testable predictions, and discuss how this perspective might be incorporated in future research.

Change in Partner Preference across the Menstrual Cycle

At first glance, choice of a partner can appear to be a fundamentally idiosyncratic process. However, evolutionary biologists argue that at least part of the complexity in partner choice (in animals and humans alike) is explained by selection pressures across evolutionary history that shape inherent preferences for opposite-sex individuals carrying traits that reflect high mate quality (Andersson, 1994). Preference for any trait that confers benefits through improved survival, health or reproductive success of offspring will spread through a population.

In mammals, female preferences among males vary with estrus (Williams & Lenington, 1993). There is now also considerable evidence from psychological studies that women's preferences for varied male traits change across the menstrual cycle. These shifts are characterized by an increased periovulatory preference for traits that signal high partner quality, such as facial masculinity (Penton-Voak et al., 1999). Stronger preferences for such traits when conception probability is high suggest an evolved mechanism by which females maximize quality of mating partners and, hence, of potential offspring (Gangestad & Thornhill, 2008; Jones et al., 2008; Penton-Voak et al., 1999). Cyclical shifts may be due to differential activational effects in the brain when processing mate choice relevant stimuli around ovulation (Roberts, Newell, Simoes-Franklin, & Garavan, 2008), which are mediated

by hormonal levels. For example, shifting preferences for masculine male faces or vocal traits are mediated by changing levels of estradiol or its metabolites (Feinberg et al., 2006; Roney & Simmons, 2008). OCs exploit these natural fluctuations, through negative feedback effects on the hypothalamus and anterior pituitary gland, suppressing gonadotropin release and inhibiting ovulation. Furthermore, they also appear to nullify or reduce the preference shifts evident in normally cycling women (Jones et al., 2008; Penton-Voak et al., 1999).

If OC use influences these preference shifts, we should see differences in mate preference between OC users and non-users. Indeed, a growing number of studies show that OC users make different mate choices, on average, than non-users, including in preferences for facial and vocal masculinity and for perceived health in faces (Alvergne & Lummaa, 2010; Jones et al., 2008; Penton-Voak et al., 1999). Furthermore, in a recent study, initiation of OC use reduced women's preference for male facial masculinity (Little, Burriss, Petrie, Jones, & Roberts, 2013). Consistent with this, the actual partners of women who were using OC when couples met were also found to have less masculine faces, both in terms of measurements of facial shape and perceptual judgments by independent raters, compared with partners of women who did not use OC when couples met (Little et al., 2013).

MHC-Correlated Partner Preference

Another well-documented factor involved in partner selection is preference for genetically dissimilar partners (Roberts & Gosling, 2003; Roberts & Little, 2008). Vertebrates achieve this using odor, which reveals dissimilarity at key genes in the major histocompatibility complex (MHC). Odor-mediated MHC-disassortative mating promotes offspring heterozygosity and is evolutionarily beneficial because of heterozygote advantage in resistance to infection. MHC-disassortative mating occurs across fish, reptiles, birds, and mammals (Milinski, 2006; Penn, 2002; Roberts, 2009; Setchell & Huchard, 2010). In some socially monogamous birds and mammals (including primates), females not only choose to

pair with MHC-dissimilar mates but are also more likely to engage in extra-pair copulations (evidenced by mixed paternity clutches) if their mate is relatively MHC-similar (Freeman-Gallant, Wheelwright, Meiklejohn, & Sollecito, 2006; Schwensow, Fietz, Dausmann, & Sommer, 2008); in so doing, they gain further genetic diversity in their offspring, with associated benefits in offspring health and survival (Foerster, Delhey, Johnsen, Lifjeld, & Kempenaers, 2003; Petrie & Kempenaers, 1998).

Humans, too, can discriminate MHC similarity through odor: in laboratory tests, women in the follicular phase tend to rate axillary odor of MHC-dissimilar men as more sexy and attractive than those of MHC-similar men (Havlicek & Roberts, 2009; Wedekind & Füri, 1997; Wedekind, Seebeck, Bettens, & Paepke, 1995). Differences in preference for MHC dissimilarity also occur between OC users and non-users, with users showing weaker preference (Havlicek & Roberts, 2009; Wedekind & Füri, 1997; Wedekind et al., 1995). It seems unlikely that differences in psychosocial factors could explain relative odor preferences, so the difference appears to be hormonally mediated. Indeed, a longitudinal study showed that initiating OC use caused a change in odor-mediated MHC preference in women, compared to a control group of non-users tested across the same (3-month) interval (Roberts, Gosling, Carter, & Petrie, 2008). If olfaction plays any part in attractiveness assessments during courtship, as it seems to (Havlicek et al., 2008), this body of work then suggests that OC use will increase the likelihood of women selecting more MHC-similar partners than they otherwise would (Roberts et al., 2008).

Defining the Object of Desire

This literature thus demonstrates potential for OC use to alter women's partner preference for a range of male traits, at a deep-seated and subconscious level. This could have important consequences on women's sexual relationships, because it alters women's attraction to their partner and, potentially, to other men. For example, in a study of U.S.

women in established relationships, those partnered with men who shared a relatively high number of MHC alleles expressed lower sexual responsivity and satisfaction with their partner compared with women whose partner was relatively MHC-dissimilar, especially near ovulation (Garver-Apgar, Gangestad, Thornhill, Miller, & Olp, 2006). Furthermore, in the same women, within-couple MHC similarity was also associated with higher frequency of women's sexual thoughts about, and actually engaging in sexual activity with, other men.

This raises a fundamental consideration for studies of the relationship between OC use and female sexual desire: a critical distinction must be made between a woman's general desire and her specific desire for her partner. Previous studies have almost ubiquitously failed to make this distinction. These studies typically employ one of a range of standard questionnaires to measure desire, but examination of these scales shows that they lack sufficient specificity in their respective lists of items. Table 1 shows the higher-order facets of female sexuality and the target (general or partner-focused) specified in the questionnaire rubric, for six of the most commonly used questionnaires when addressing this question. While each contains items that quantify general sexual desire, not one contains an item specifically about desire for (nor indeed about arousal, lubrication or orgasm during sex with) the woman's main sexual partner. Furthermore, even though several questionnaires contain items relating to partner-focused sexual satisfaction, which is likely correlated with desire, these items are often subsumed within global sexuality scores or in desire subscales which also incorporate general sexual desire (e.g., Panzer et al., 2006; Wallwiener et al., 2010).

Failing to make this distinction potentially conflates two very different forms of sexual desire and experience. Discounting research emerging from the literature on OC influence on partner choice (Roberts et al., 2012), a study by Bancroft, Sherwin, Alexander, Davidson, and Walker (1991), to our knowledge, is the only one to have yet made this distinction, which makes it of particular interest. Their main goal was to examine the

influence of testosterone on sexual attitude and behavior, and they included groups of OC users and non-users because of the known effects of OC use on lowered testosterone. Interestingly, they did not find the predicted relationships in non-users, but, in OC users, testosterone predicted lower satisfaction with the woman's relationship at the same time as a more permissive attitude to extramarital involvement. This seems strongly reminiscent of the effects of MHC allele sharing on women's sexual behavior. Bancroft et al. concluded that this effect probably arose through psychosocial factors more evident in non-users (e.g., cyclical mood change) obscuring the activational effects of testosterone on sexuality. This is certainly plausible, but an alternative view is that it arises not because of characteristics of non-users masking these activational effects, but rather through a change in partner preference in the OC users, which then brings the predicted activational effects to the fore.

The Congruency Hypothesis

Studies demonstrating the influence of OC on partner choice also lead to a novel but simple model for understanding interactions between timing of previous and current oral contraceptive use, relationship initiation, and partner-focused desire. This is that congruence between current OC use and previous use (specifically during relationship formation) should more accurately predict a woman's sexual desire for, and satisfaction with, her partner than current OC use in isolation. This is because if a woman's OC use is congruent (i.e., current OC users who were OC users when they met their partner, current non-users who were non-users when they met their partner), her current preference will more closely match the preference that shaped her partner choice in the first place; the corollary is relatively higher desire for that partner than a woman whose use is incongruent (Fig. 1).

This idea potentially explains some previously reported effects. In prospective studies, participants are often young women in committed relationships who have not used hormonal contraception for at least a significant period. It seems reasonable to suppose that many

women in such samples were non-users when their relationship began, and the commonly reported experience of decreased sexual desire after initiating OC use is then consistent with this hypothesis. A significant difference in effect between married and age-matched single women, with the former being more likely to experience decreased desire when prescribed OC's (Gambrell, Bernard, Sanders, Vanderburg, & Buxton, 1976), is also consistent with this idea.

The hypothesis generates testable predictions. One is that women who meet their partner while using OC will tend to experience decreased desire when they subsequently cease use, as their partner preferences realign to their baseline state. A recent study tested this prediction in a survey of >2500 women. As predicted, among current non-users, those who had used OC when they met their partner reported lower attraction to, and lower sexual satisfaction with their partners, compared with those who had been non-users (Roberts et al., 2012). A second, but so far untested, prediction is that women who were non-users when they met their partner and who subsequently initiate OC use will tend to experience similar negative effects on sexual desire, arousal, and satisfaction.

Thus, the congruency hypothesis suggests that decreased desire could be experienced both by ceasing and initiating OC, critically depending on the individual's OC use when the relationship began (Fig. 1). This could help to explain the consistently high variation in women's experience that is characteristic of previous studies.

Future Directions

There is growing recognition of the importance of evolutionary insights in complementing other approaches to medicine (Stearns, Nesse, Govindaraju, & Ellison, 2010). To the longstanding debate about OC use and adverse sexual side-effects, the evolutionary perspective on partner choice offers two new, potentially important contributions. Both serve to contextualize aspects of the women's experience, and both have the potential to explain

previous patterns of results, probably in combination with each other. This is not to definitively conclude that other mechanisms are unimportant. For example, altered desire due to suppression of circulating testosterone during OC use may act in conjunction with these effects, or be obscured by them. However, weighing effects of testosterone suppression against other factors, Pastor et al. (2013) concluded in their recent review that psychological, social and personal characteristics exert greater influence. On this basis, and in view of the evolutionary evidence, we suggest that OC effects on partner choice now deserve rigorous consideration alongside other approaches.

The following prospective study would provide a definitive test of these ideas, stemming from the second prediction generated by the congruency hypothesis. Researchers could recruit an appropriate sample of women in committed relationships, half of whom were on (and half off) OC when they met their partner, with none being current users. The study would measure change in desire across the transition to OC use. A control group of non-users, half of whom used OC when they met their partner, receive a placebo. Because psychosocial effects on relationship-relevant variables are sensitive to estradiol dose within OCs (Cobey et al., 2012; Cobey, Pollet, Roberts, & Buunk, 2011; Welling, Puts, Roberts, Little, & Burriss, 2012), the tested OC formulation would ideally be similar to the women's previous brand. The hypothesis would predict that (1) there will be greater absolute (i.e., unsigned) change in desire in the treatment group, and that OC initiation leads to (2) increased desire among women who were using OC when they met their partner and (3) decreased desire among women who were non-users when they met their partner.

However, in any future work (not just the study outlined above), the evidence also highlights the need for greater attention to certain aspects of study design. First, more care is needed in interpreting how other facets of female sexual experience might relate to desire (Basson, 2008; Levine, 2003). While arousal, lubrication, frequency of sex/orgasm, and

satisfaction may be motivationally interlinked and underpinned by the degree of current attraction to the woman's partner, autosexual behavior may be motivationally distinct and perhaps inversely related with partner attraction. However, currently, this is included in two of the commonly used measures (Table 1) and in calculation of global sexuality scores in some studies (e.g. Caruso et al., 2005).

Second, measures of desire need to be fit for purpose. This is a more important point than engaging in a debate about which measure to use or about wording of individual items. Our contention is that none of the commonly used questionnaires adequately capture the subtle, but potentially critical, changes in the target of women's desire exposed by the evolutionary perspective. Future studies should thus use a measure that explicitly identifies the target of different facets of sexual behavior, dissecting the expression of desire and experience to distinguish between a woman's main sexual partner and other partners (real or imagined). We are aware that women's attitudes towards extra-pair sex is variable and that this variability may introduce further complexity in measuring effects (Levine, 2003); however, the available evidence suggests this can be informative (Garver-Apgar et al., 2006), and well-recognized measures exist to control for this variability (e.g., the revised Sociosexual Orientation Inventory) (Penke & Asendorpf, 2008).

Finally, the literature on OC use and partner preference, along with parallel effects of OC's on factors such as relationship jealousy (Cobey et al., 2012), emphasize the need for studies to record and control for relationship status. It is perhaps remarkable that several studies fail to do this (e.g. Fortenberry & Hensel, 2011; Panzer et al., 2006). Even in those that do, including many who specifically recruit partnered women, few record changes in relationship status across the study. However, women whose status changes during the study should in our view be routinely excluded from relevant analyses.

Summary

It is now almost two decades since the idea that partner preference might be influenced by OC use was first proposed (Wedekind et al., 1995), but this rapidly growing body of evolutionarily informed research has been overlooked by contraception practitioners in general (Cobey & Buunk, 2012), and by those working on psychosexual effects of hormonal contraception in particular (Burrows et al., 2012; Davis & Castano, 2004; Pastor et al., 2013; Schaffir, 2006). It may be that something as apparently esoteric as individual preferences for partners is simply viewed with skepticism, or clinical researchers may be unaware of it. Either way, we hope this Letter will stimulate researchers to incorporate these contextual perspectives when investigating these effects in future, and that this may ultimately lead to more informed discussion between practitioners and users about their contraceptive choices, and better understanding by users of the potential consequences for their sexual relationships.

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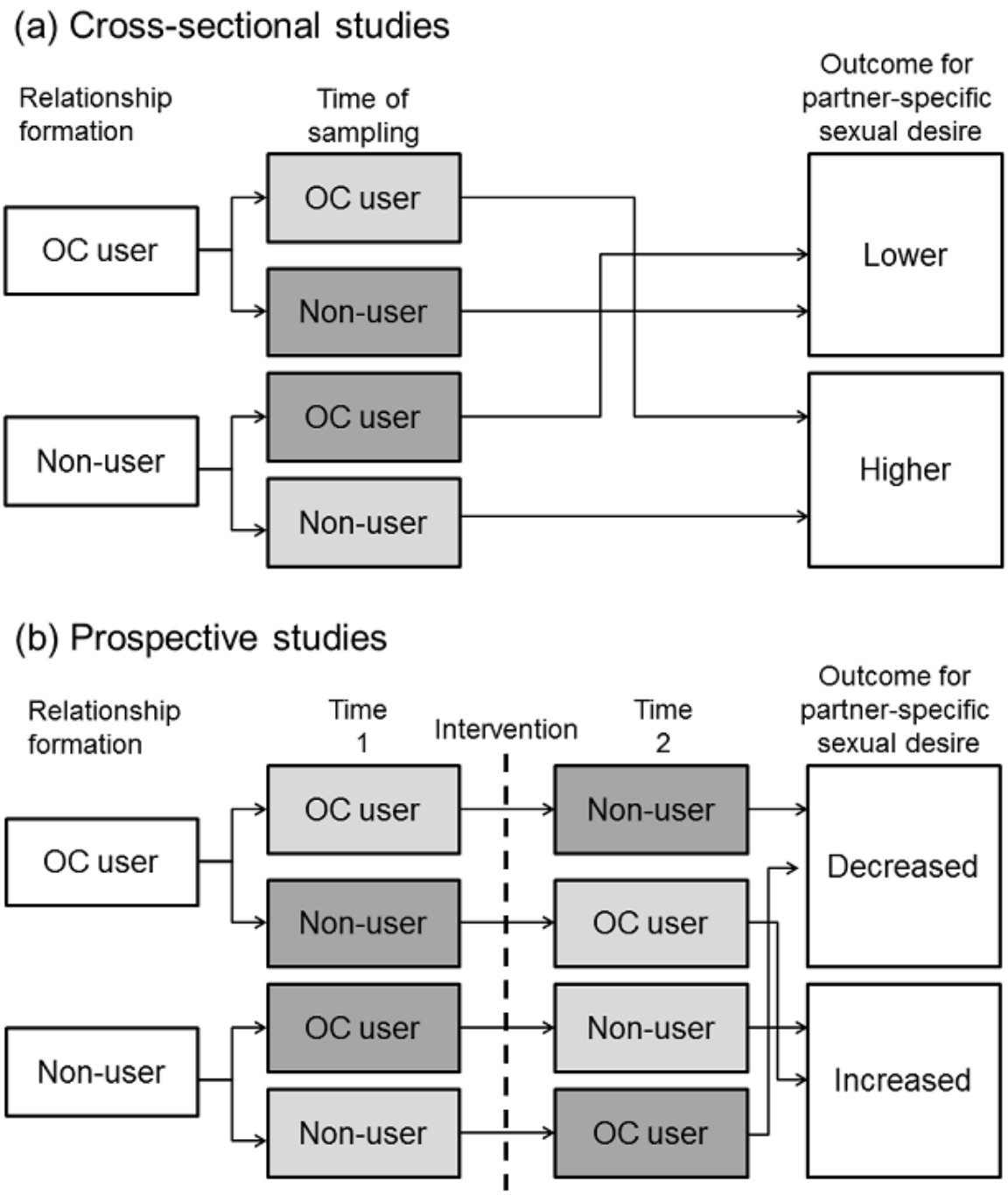
Table 1 Facets of sexual experience in questionnaires exploring associations between oral contraception and sexual functioning.

Facet and target[a]	Questionnaire[b]					
	FSFI	**MFSQ**	**SDI**	**SEQ**	**PEQ**	**SPEQ**
General						
Desire	+	+	+	+	+	+
Arousal	+	+	-	-	+	+
Lubrication	+	+	-	+	+	-
Orgasm	+	+	-	-	+	+
Satisfaction[c]	+	+	-	+	+	+
Pain	+	+	-	-	-	+
Frequency	-	+	-	-	+	+
Autosexual	-	-	+	-	+	-
Partner-focused						
Desire	-	-	-	-	-	-
Arousal	-	-	-	-	-	-
Lubrication	-	-	-	-	-	-
Orgasm	-	-	-	-	-	-
Satisfaction[c]	+	+	-	-	+	+
Pain	-	-	-	-	+	-
Frequency	-	-	-	-	+	-

[a]Facets are presented separately for questionnaire items dealing with general sexual functioning and those specifically targeted at sex with a woman's main partner.
[b]Questionnaires: FSFI, Female Sexual Function Index (Rosen et al., 2000); MFSQ, McCoy Female Sexuality Questionnaire (McCoy, 2000); SDI, Sexual Desire Inventory (Spector, Carey, & Steinberg, 1996); SEQ, Side Effects Questionnaire (Sanders et al., 2001); PEQ, Personal Experiences Questionnaire (Dennerstein, 1997); SPEQ, Short Personal Experiences Questionnaire (Dennerstein, Lehert, & Dudley, 2001). [c]Includes items about enjoyment.

Figure 1. Congruency in current and previous OC use: effects on partner-specific desire. The figure shows how, according to the congruency hypothesis, congruency (light grey shading) or non-congruency (dark grey) in OC use between different critical periods predicts variation in partner-specific desire. (**a**) In cross-sectional studies, OC use during sampling may be associated with both higher and lower levels of partner-focused desire dependent on previous use during relationship formation. (**b**) In prospective studies, an intervention (i.e. initiating or discontinuing OC use) may induce similar mixed effects.


(a) Cross-sectional studies
Relationship formation
Time of sampling
Outcome for partner-specific sexual desire
OC user
OC user
Non-user
Non-user
OC user
Non-user
Lower
Higher
(b) Prospective studies
Relationship formation
Time 1
Intervention
Time 2
Outcome for partner-specific sexual desire
OC user
OC user
Non-user
Non-user
OC user
Non-user
OC user
Non-user
Decreased
Increased