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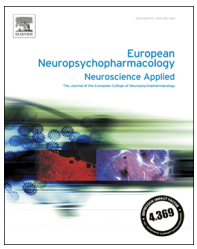

Affective responsiveness is influenced by intake of oral contraceptives

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Abstract
Despite the widespread use of oral contraceptive pills (OCs), little is known about their impact on psychological processes and emotional competencies. Recent data indicate impaired emotion recognition in OC users compared to naturally cycling females. Building upon these findings, the current study investigated the influence of OC use on three components of empathy, i.e., emotion recognition, perspective-taking, and affective responsiveness. We compared naturally cycling women to two groups of OC users, one being tested in their pill-free week and one in the phase of active intake. Whereas groups did not differ in emotion recognition and perspective-taking, an effect of pill phase was evident for affective responsiveness: Females currently taking the pill showed better performance than those in their pill-free week. These processing advantages complement previous findings on menstrual cycle effects and thereby suggest an association with changes in endogenous and exogenous reproductive hormones. The current study highlights the need for future research to shed more light on the neuroendocrine alterations accompanying OC intake.

1. Introduction

Oral contraceptive pills (OCs) have revolutionized societal conventions on sexuality and gender roles by empowering women to control their fertility. In contrast to well-known physical effects, psychological and behavioral consequences of OC use have been vastly under-researched. Even within

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this domain, the focus lies on mood and depressive symptoms (Pletzer and Kerschbaum, 2014), i.e., a general, diffuse emotional climate. OC-associated changes in specific emotional reactions to stimuli, however, were first reported only recently as coincidental findings by Hamstra and colleagues (2014). Compared to naturally cycling women, OC users recognized fewer facial expressions of anger, sadness and disgust, which was partially modulated by mineralocorticoid receptor haplotypes (Hamstra et al., 2015).

Correctly identifying the emotional states of others is essential for social interactions and has been associated with higher relationship quality, and a lowered rate of depression (Carton et al., 1999). If OC use is linked to a reduced ability to recognize emotions, this might ultimately have negative consequences for relationship quality, e.g., by leading to more conflict. In light of the association between OC use and relationship satisfaction (Roberts et al., 2014) as well as the widespread use of OC across the globe, effects of OC are of interest to millions of users, their partners and society.

Emotion recognition is one essential component of empathy as defined by Decety and Jackson (2004). Empathy further consists of both cognitive and emotional reactions to others' experiences (Dziobek et al., 2008; Shamay-Tsoory, 2011; Shamay-Tsoory et al., 2009). The cognitive component of perspective-taking, i.e., inferring the mental state of others, is distinct from affective responsiveness, i.e., sharing others' emotional states.

Here, we investigated the influence of OC use on these three core aspects of empathy and compared naturally cycling women to two groups of OC users, one being tested in their pill-free week and one in the phase of active intake. Based on the results by Hamstra et al., we expected better performance in emotion recognition in naturally cycling females than in OC users. We further explored a potential modulation of cognitive and emotional empathy by OC use and the time of testing. Previous findings in naturally cycling women point towards faster affective responsiveness during the luteal phase compared to the follicular phase, but towards stable perspective-taking performance across the cycle (Derntl et al., 2013). Complementary processing advantages in affective responsiveness might thus emerge during the phase of active OC intake, while perspective-taking is assumed to remain unaffected.

2. Experimental procedures

2.1. Sample

Seventy-three healthy females (M age=23.07, SD=1.93, of which n=65 were students) were recruited via postings at the RWTH Aachen University, Social Media, and personal networks. Eighteen females were naturally cycling ("no pill"), and the remaining females were taking monophasic combined OCs. OC-users were divided into two groups based on their current intake status: 25 were in their pill-free week ("off pill"), i.e., at least one day without taking OC, and 30 were currently actively taking the pill ("on pill"), i.e., having taken at least two pills. Duration of OC use and current brand name were registered, and OC types were classified based on progestin compounds. All OC users had been taking the current brand for at least three months, and all naturally cycling females had not been taking the pill for at least three months. Exclusion criteria were age <18 or >35, the use of other hormonal contraceptives (e.g., NuvaRing®), and current or past psychiatric or neurological disorders. The study was approved by the local ethics committee. All participants received written information about the experiment and subsequently provided written informed consent.

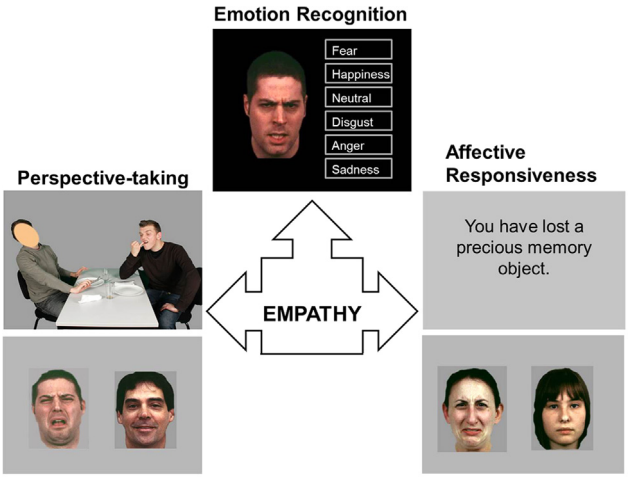

Figure 1 Illustration of the three components of empathy according to Decety and Jackson (2004) and the tasks measuring emotion recognition, perspective-taking and affective responsiveness.

2.2. Tasks (see Figure 1)

2.2.1. Emotion recognition

Stimuli consisted of 36 colored pictures of Caucasian faces depicting five basic emotions (happiness, sadness, anger, fear, and disgust) and neutral expressions, which had been selected from Gur et al. (2002). On each trial, one expression was presented on the left side of the screen, and six verbal labels were presented on the right side. Participants had to identify the correct emotion as fast and accurately as possible, but stimuli remained on the screen until a response was given. Pressing the up/down arrow keys on the keyboard moved the highlighted label vertically and pressing the space bar confirmed the choice. The starting position of the highlighting was counterbalanced across trials (Figure 1).

2.2.2. Perspective-taking

Stimuli consisted of 36 colored pictures showing two Caucasians involved in a social interaction, which portrayed a basic emotion (happiness, sadness, anger, fear, and disgust) or an emotionally neutral situation. On each trial, one scene was presented for 4 s with the face of one person being masked. Participants had to infer the emotional expression of the masked face. After a fixation cross (1 s), two different facial expressions appeared as response options (one being correct, one being selected at random from the remaining stimulus pool described above). Participants were asked to select the correct state as fast as possible by pressing the left/right arrow key within 4 s. Participants were told not to base their selection on the age or sex of the person but only on the emotional expression.

2.2.3. Affective responsiveness

Stimuli consisted of 36 short sentences describing real-life situations aimed at inducing a basic emotion (happiness, sadness, anger, fear, and disgust) or an emotionally neutral state. On each trial, one sentence was presented in the center of the screen in black font on

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