Sexual Hormones Influence Gray's Theory of Personality*

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Personality is believed to be stable throughout adulthood. However, many personality theories are based on the construct of measuring subjectively reported reactions of a person during specific, mostly emotional situations. Thus, the component "emotion" plays a crucial role in determining personality traits, especially within the BIS (behavioral inhibition system)/BAS (behavioral activation system) questionnaire. Sexual hormones, in terms of the menstrual cycle, are found to be influential on emotional processing (e.g., emotion recognition, mood, and emotional evaluations). As a consequence, we hypothesized that personality measured with the BIS/BAS shows menstrual cycle effects and thus gender differences dependent of the menstrual cycle phase. In Study I, we collected BIS/BAS data from female subjects ($n = 48$) in different menstrual cycle phases (23 follicular/25 luteal). Comparing both phases, we found significant values within the BAS-dimension for the follicular women with medium effect sizes. In Study II, we collected additionally BIS/BAS data from men ($n = 22$). Comparing them to the female data, we found significant higher BIS values for women in general and especially for luteal women. These differences are discussed to be estrogen and progesterone mediated.

Keywords: menstrual cycle, sexual hormones, personality, BIS (behavioral inhibition system)/BAS (behavioral activation system)

Introduction

Gender differences are still a matter of debate in psychological investigations. There are still stereotypical assumptions about male personality, as being powerful and rational whereas females are emotional, which substantiates the famous title of John Grays "Men are from Mars and women are from Venus" (Gray, 1992). A recent publication starts this debate again, about the underestimation of gender differences in personality constructs of past studies (Del Giudice, Booth, & Irwing, 2012) (e.g., including the gender-similar hypothesis (Hyde, 2005)).

One possibility to explain the source of gender differences is sexual hormones. This topic is often

* **Acknowledgements:** This research was supported by grants from the Transregional Collaborative Research Center Sonderforschungsbereich/Transregio 62 "Companion-Technology for Cognitive Technical System" funded by the DFG (German Research Foundation) and a doctoral scholarship by the University of Ulm for Stefanie Rukavina.

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discussed and found to be a moderate variable on different psychological research questions as they play an important role since the embryonic development of every human. In this time frame, they are responsible for several “structural” differences between male and female brains. Goldstein, Seidman, Horton, Makris, Kennedy, and Caviness (2001) found sexual dimorphisms in the human brain, especially in the limbic areas. In accordance with that, the highest concentration of steroid receptors was found in the amygdala (Osterlund, Keller, & Hurd, 2000; Ter Horst, 2010), implicating an important modulating effect of steroid hormones. Thus, gender differences in emotional responding due to different hormone concentrations can be expected and are demonstrated in some studies (e.g., emotion recognition and empathy (Hampson, Van Anders, & Mullin, 2006; Hoffmann, Kessler, Eppel, Rukavina, & Traue, 2010; Orozco & Ehlers, 1998; Schulte-Ruther, Markowitsch, Shah, Fink, & Piefke, 2008)). However, the inconsistent findings of some studies might be explained by the impact of fluctuating steroid hormones of women in terms of the menstrual cycle, which could be shown in literature for emotion recognition (Derntl, Kryspin-Exner, Fernbach, Moser, & Habel, 2008; Guapo, Graeff, Zani, Labate, dos Reis, & Del-Ben, 2009), fear network (Lebron-Milad & Milad, 2012; Milad, Goldstein, Orr, Wedig, Klibanski, & Pitman, 2006), brain's arousal circuitry (Andreano & Cahill, 2010), and mood (Davydov, Shapiro, & Goldstein, 2004; O'Reilly, Cunningham, Lawlor, Walsh, & Rowan, 2004). According to these findings, the greatest gender differences would be expected when comparing men and women during their luteal phase (see below) and the lowest difference would be expected during menstruation because of their relatively similar hormonal profiles. This relation was found in gender differences concerning cognitive spatial abilities (Hausmann, Slabbekoorn, Van Goozen, Cohen-Kettenis, & Gunturkun, 2000).

Most personality traits are based on subjective reports of reactions in emotional situations, therefore, it is really interesting that only a few studies searched for the influence of sexual hormones on the personality level. But the research field of the influence of sexual hormones on behavior and personality seems to be in progress. For Gray's BIS (behavioral inhibition system)/BAS (behavioral activation system) personality traits, Vermeersch and colleagues (2009) found a positive correlation between estrogen and the BAS-D (BAS-drive) scale in young females (Vermeersch, T'Sjoen, Kaufman, & Vincke, 2009). Gray's (1981) personality theory was designed to explain differences of individuals in emotional behavior and consists of three systems—BIS, BAS, and the FFS (fight/flight system) (which is not further considered in this study). Developed on the basis of animal and pharmacological studies from a very bio-psychological view, the BIS/BAS dimensions offer the opportunity to look for the impact of gender and sexual hormones on behavioral differences. Although some gender differences for the BIS/BAS scales are reported (Jorm, Christensen, Henderson, Jacomb, Korten, & Rodgers, 1999), there is still no definite congruency about the impact of the biological sex and the specific sexual hormones on personality.

Summarizing the above-mentioned studies, these sometimes inconsistent findings demonstrate the need to investigate the influence of sexual hormones during the menstrual cycle and in terms of gender differences on personality further and more in detail.

Therefore, our study aimed to search for these differences by using a well-validated German version of the BIS/BAS scale (Strobel, Beauducel, Debener, & Brocke, 2001).

In Study I, we collected and analyzed the BIS/BAS data with respect to the menstrual cycle. We got two female groups: one in the follicular and one in the luteal phase. In Study II, we compared the BIS/BAS data from Study I with new collected data of men to look for gender differences, regarding the menstrual cycle effect.

Menstrual Cycle

The menstrual cycle consists of different phases according to different hormone concentrations (see Figure 1). FSH (follicle stimulating hormone), LH (luteinizing hormone), estrogen, and progesterone fluctuate monthly with the beginning of puberty. Taking a standard cycle length of 28 days, the menstruation starts at day 1 per definition and lasts until about day 7. In this “early follicular phase”, the concentrations of estrogen and progesterone are low-leveled. At about day 7, the follicle starts growing and the concentration of estrogen increases. This “late follicular phase” ends with a large amount of LH at about day 12. Within the next 24–48 hours, the ovulation will take place and the “luteal phase” begins with an increase of progesterone due to the corpus luteum and a second low increase of estrogen. With the beginning of menstruation, a new cycle starts.

Figure 1. The standard menstrual cycle (about 28 days) begins with menstruation at day 1 and consists of the main hormonal profiles of FSH, LH, Estrogen, and Progesterone. In the middle of the cycle, the Ovulation takes place.

Materials

The BIS/BAS questionnaire is designed to measure two parts of the motivational system (Carver & White, 1994). The BAS scale is subdivided in BAS-FS (BAS-fun seeking), BAS-RR (BAS-reward responsiveness), and BAS-D. These three dimensions measure the drive/impulse to go for the stimulus, the reward sensitivity, and the fun-seeking behavior. Whereas the BAS system is associated with the sensitivity to conditioned signals of reward and free of punishment, the BIS system mediates the sensitivity to signals of punishment and non-reward behavior (see Figure 2). In addition, the BIS and BAS-RR scales refer more to the sensitivity towards specific events, whereas BAS-D and BAS-FS refer more to actions people take in these specific events.

Figure 2. The BIS/BAS system is activated by a specific stimulus and after a decision mechanism (according to Arnett and Newman, 2000), one approaches the stimulus or avoids it.

For the BIS/BAS questionnaire, a well-validated German translation (Strobel, Beauducel, Debener, & Brocke, 2001) was used to avoid language problems. It consists of 24 questions about the subjects' feelings, activating the BIS or BAS system, which can be answered by a 4-point Likert scale.

The data analysis was done with the Statistic Program IBM SPSS (Statistical Product and Service Solutions) Statistics Version 20.

Study I

Hypotheses

According to the existing literature, we assumed that estrogen has a positive effect on the BAS-dimensions (Vermeersch et al., 2009). Therefore, follicular women were intended to have higher BAS values than luteal women. Because progesterone is known to minimize the effect of estrogen and is believed to be responsible for higher stress responses and bad mood in the luteal phase (Andreano & Cahill, 2010), we expected higher BIS values within the luteal phase compared to follicular women.

Subjects

For measuring the influence of the menstrual cycle, we differentiated between one follicular group ($n = 23$, average age = 23.91, $SD = 3.60$) and one luteal group ($n = 25$, average age = 25.88, $SD = 4.93$). Both groups did not take hormonal contraceptives for at least three months before participation. Every subject checked her menstrual cycle length in advance to avoid false calculation of the follicular phase and informed us about their day 1 (menstrual onset). With regard to the hormonal status, follicular women were recruited individually dependent on their menstrual cycle (according to Sato, Miyake, Akatsu, and Kumashiro, 1995) between the days 7–13 after onset of menstruation. But we did not specifically want the ovulation phase, therefore, if the session day was close to the possible time of ovulation (which depended on their individual cycle length), women had to use an ovulation test prior to the experiment. This test had to be negative for excluding a forthcoming ovulation¹. In contrary, luteal women had to have a positive ovulation result. This was the proof for us that the luteal phase was induced. With the assumption, that 14 days after the ovulation menstruation normally starts, we counted the days to the probable next menstrual onset (3–8 days prior to the next onset of menstruation) (Little & Zahn, 1974). All women had regular menses, with a maximum length of 40 days and a minimum length of 21 days, forced by the package leaflet of the ovulation test.

All participants (right-handed) confirmed in writing that their participation was voluntary in accordance to the ethical guidelines (ethics commission 245/08_UBB/se). Every female filled out a self-constructed screening instrument for PMS (premenstrual syndrome) including the criteria of ICD (International Criteria of Diseases) 10, but none of them reported serious complaints.

Procedure

The female subgroups were invited to the experiment during the follicular and luteal phase respectively. The subjects used the ovulation tests at home and informed us about the ovulation test results. Adjacently, they were invited to our lab to fill out the questionnaire. The required time for filling out the questionnaire differed individually but took approximately about 10 minutes.

¹ Ovuquick Ovulation Test, NanoRepro AG, Untergasse 8, 35037 Marburg.

Results Study I

Analyses with the student's *t*-test revealed the following results.

We found significant differences for the BAS-D ($t_{(46)} = 1.918$, $p = 0.031$), BAS-FS ($t_{(46)} = 2.198$, $p = 0.017$), and BAS-total ($t_{(46)} = 2.147$, $p = 0.019$). There were no significant differences for the categories BAS-RR and BIS (see Table 1).

Table 1

Mean Values, SD, and Results of Student's T-test for the Comparison of the Menstrual Cycle Phase, Women, and Men and Especially Luteal Women and Men

Menstual cycle		<i>n</i>	Mean (<i>SD</i>)	<i>t</i>	<i>df</i>	<i>p</i>
BAS-total	follicular	23	3.318 (0.303)	1.918	46	0.031
	luteal	25	3.130 (0.305)			
BAS-D	follicular	23	3.272 (0.361)	2.198	46	0.017
	luteal	25	3.050 (0.433)			
BAS-FS	follicular	23	3.261 (0.423)	2.147	46	0.019
	luteal	25	2.990 (0.430)			
Gender		<i>n</i>	Mean (<i>SD</i>)	<i>t</i>	<i>df</i>	<i>p</i>
BAS-total	female	48	3.219 (0.315)	-0.265	68	0.395
	male	22	3.241 (0.324)			
BAS-D	female	48	3.156 (0.411)	0.397	68	0.346
	male	22	3.113 (0.427)			
BAS-FS	female	48	3.119 (0.443)	0.743	68	0.229
	male	22	3.215 (0.613)			
BAS-RR	female	48	3.350 (0.385)	-0.147	68	0.441
	male	22	3.363 (0.287)			
BIS-total	female	48	2.949 (0.445)	2.307	68	0.012
	male	22	2.668 (0.527)			
Luteal women vs. men		<i>n</i>	Mean (<i>SD</i>)	<i>t</i>	<i>df</i>	<i>p</i>
BAS-total	luteal	25	3.129 (0.305)	-1.220	45	0.114
	men	22	3.241 (0.324)			
BAS-D	luteal	25	3.050 (0.433)	-0.505	45	0.307
	men	22	3.113 (0.427)			
BAS-FS	luteal	25	2.990 (0.429)	-1.475	45	0.073
	men	22	3.215 (0.613)			
BAS-RR	luteal	25	3.304 (0.412)	-0.580	43	0.282
	men	22	3.363 (0.287)			
BIS-total	luteal	25	2.971 (0.418)	2.157	40	0.018
	men	22	2.668 (0.527)			

As an efficacy criterion of the significant results, Cohen's effect size (*d*) was calculated (Cohen, 1992), as it measures the distance of the two standardized means with the pooled standard deviations (*SD*), see (1):

$$d = \frac{x_1 - x_2}{\sqrt{(s_1^2 + s_2^2)/2}} \quad (1)$$

We got effect sizes of 0.06 for BAS-total, BAS-D, and BAS-FS, which indicates a difference of medium size.

The analysis of internal consistency with Cronbach's alpha resulted in: BIS ($\alpha = 0.70$), BAS-total ($\alpha = 0.75$), BAS-D ($\alpha = 0.61$), BAS-FS ($\alpha = 0.62$), and BAS-RR ($\alpha = 0.59$). Besides, the internal correlation of

BAS-RR every scale achieved an adequate value, thus, the information seems to be reliable. Summarized, we could confirm our hypotheses only partially, as we found no significant difference within the BIS-dimension.

Study II

In the second study, we collected data from men (matched for age) to investigate the influence of progesterone on the BIS-dimension. Because we found no significance within the BIS-dimension for the comparison of follicular *vs.* luteal, we expect luteal women to have higher BIS values than men, due to the higher progesterone concentration.

Hypotheses

According to some findings in literature (Jorm et al., 1999; Strobel et al., 2001), we expected women in general to have significant higher BIS values compared to men. Because of the findings of Sakaki and Mather (2012), we expected especially luteal women to have higher BIS values compared to men, because of the higher concentration of progesterone.

Subjects

We collected the BIS/BAS data from men ($n = 22$, average age = 24.22, $SD = 4.022$) and compared them to the female group (female subgroup together ($n = 48$, average age = 24.94, $SD = 4.417$)), see Study I. The subjects were right-handed and provided written informed consent.

Results Study II

A *t*-test analysis of the comparison of females and men revealed a significant difference in the BIS-dimension ($t_{(68)} = 2.307$, $p = 0.012$; see Table 1). The calculation of Cohen's *d* resulted in the effect size of $d = 0.6$. The comparison between luteal women and young men showed, that luteal women have significant higher BIS values than men ($t_{(40)} = 2.157$, $p = 0.018$). For the comparison between follicular women and men, we achieved a significant result of ($p = 0.0475$) indicating that follicular women differ in the BIS-dimension compared to men. Our hypothesis about women having higher BIS values in general compared to men could be confirmed. Though luteal women have a larger mean difference, there was also a statistical difference between follicular and men observable.

Discussion

The concept of describing personality by two motivational systems—BIS/BAS—goes back to (Gray, 1982). These two systems mediate behavior moving towards a stimulus or to shrink back from a stimulus, especially if a person is afraid of punishment. According to Gray (1982), two different neurobiological circuitries are controlling the two behavioral tendencies. While the BAS is associated with the dopaminergic system, the BIS is associated with septo-hippocampal system and also with the amygdala. Due to a high density of steroid receptors in these neurobiological structures (especially the limbic area), differences in personality items like for the BIS/BAS can be expected, not only concerning gender but even during the menstrual cycle. However, according to the so-called plaster theory, personality is regarded as a stable construct that should not change after maturation/early adulthood. Although, age was shown to have an effect on personality (e.g., neuroticism values decline in older women (Srivastava, John, Gosling, & Potter, 2003)). Other theorists believe, that a changing personality is a side effect of growing older, as a consequence of declining cognitive abilities (McCrae & Costa, 1999).

We tried to enlighten the effect of sexual hormones on the BIS/BAS items with a between-subject design. Therefore, we collected data of two different menstrual cycle groups (follicular phase *vs.* luteal phase) in Study I. According to the findings of Vermeersch et al. (2009) of estrogen influencing the BAS-D values, we expected higher BAS-D values for the follicular women compared to the luteal women. Indeed, we found significant higher BAS-total, BAS-D, and BAS-FS values with a medium effect size of 0.6. Concerning our sample size, these medium effects substantiate the hypothesis of estrogen having a modulating effect on behavior. This relation is described in a recently published review (Lebron-Milad & Milad, 2012) and animal studies provide further arguments for this assumption (Becker & Hu, 2008). The BAS system is related to the dopaminergic reward circuitry. Due to the fact that the BAS scale resembles the sensitivity to conditioned reward signals, this matches to the fact of a higher self-consciousness and a higher well-being of women in the follicular phase (Farage, Osborn, & MacLean, 2008). Especially, the BAS-FS scale refers to actions people take in specific situations. Since this system is involved in emotion regulation and mood, the higher well-being as a consequence is not surprising. Interestingly, we found no significance for the BAS-RR, although estrogen also activates the reward response (Sakaki & Mather, 2012). But, for this scale, we got a very low internal consistency with Cronbach's alpha, which could have a negative effect on the evaluation of the results within this dimension.

Our hypothesis about luteal women showing higher BIS values was not confirmed. To test, whether progesterone is responsible for higher BIS values, a comparison between luteal women and young men could enlighten this problem. This could also explain gender differences for the reactions to negative stimuli (Bradley, Codispoti, Sabatinelli, & Lang, 2001). In Study II, we showed, that women in general have significant higher BIS values than men, and that especially luteal women have significant higher BIS values. According to the theory that the greatest gender difference could be expected during the greatest difference of hormonal profiles, for the BIS-dimension, this is correct. However, we found no gender difference within the BAS-dimension. The influence and consequences of progesterone during the luteal phase have been studied with the means of a replacement therapy with menopausal women (Girdler, O'Brian, Steege, Grewen, & Light, 1999). Most women showed higher anxiety traits and an increase in depression, which matches to the behavioral inhibition system, especially regarding the non-reward behavior.

The impact of sexual hormones during the menstrual cycle on BIS/BAS has been tested in another (Hwang, Chen, Yeh, P. C. Tu, C. H. Tu, & Hsieh, 2008), but they did not reach significant results. One possibility is the smaller sample size. Another possibility is that the within-subject design is not appropriate enough to measure small differences, since the BIS/BAS questionnaire consists of general questions and is not restricted to a definite time frame. Maybe the reference of the last 48 hours within the questions would have displayed the influence of sexual hormones better. Another reason could be the menstrual phases compared to Hwang et al. (2008). Although, according to our findings, they should have found differences in the BAS-dimension. To substantiate our results, Study I should be repeated with a within-subject design in further experiments.

The limitations of our study was the solely use of ovulation tests to determine the two menstrual cycle phases. Though the sensitivity is standardized, it may be too insensitive for all women. Thus, there could be some diffusion occurred about the determination of the "right" menstrual cycle phase. Measuring the sexual hormones by taking blood or saliva samples would have resulted in data about hormonal concentrations and would have made a correlation analysis between hormone levels and personality data possible. However, all

females controlled their cycle and informed us about the onset of their menses, so we were able to double-check their menstrual phases. Another limitation was the small sample size of our population in Studies I and II and the choice of a between-subject design. Therefore, it is planned to repeat this study with a within-subject design.

Conclusions

We conclude on the basis of our hypotheses that sexual hormones not only change the well-being of women, cognitive performances, or emotional ratings. It seems that they even affect “personality” measured with the BIS/BAS scales, a bio-psychological point of view. One important finding was that estrogen seems to be responsible for the differences in the BAS-dimension between women in the follicular and luteal phase, whereas progesterone seems to be responsible for higher BIS values in women, especially in the luteal phase compared to men.

Further studies should consider the menstrual cycle and fluctuating sexual hormones as mediating factors of personality.

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