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Implicit motives and gonadal steroid hormones: effects of menstrual cycle phase, oral contraceptive use, and relationship status

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Abstract

Implicit motives for power and affiliation, salivary levels of testosterone, estradiol, and progesterone, and relationship status were measured in 18 normally cycling (NC) women, 18 women using oral contraceptives (OC), and 18 men at three assessments, corresponding to the menstrual, midcycle, and premenstrual phases of women's menstrual cycle. NC and OC women had elevated levels of affiliation motivation and decreased levels of power motivation at midcycle. Power motive changes were particularly pronounced in NC women across cycle phases. OC women and participants not engaged in an intimate relationship had significantly heightened levels of affiliation motivation, averaged across all cycle phases. Testosterone and power motivation, both averaged across all cycle phases, were positively correlated in men and in single women, but not in women engaged in an intimate relationship. Averaged levels of estradiol and power motivation were positively correlated in engaged women, but not in single women or men. Averaged levels of progesterone and affiliation motivation were negatively correlated in men, and there was evidence for a positive association between luteal affiliation motivation and periovulatory and luteal progesterone in NC women. This study therefore provides evidence that implicit motivational states fluctuate across the menstrual cycle, that the power motive is associated with testosterone and, in women, with estradiol, and that the affiliation motive and progesterone are associated in different ways in men and NC women.

Keywords: Salivary testosterone; Salivary estradiol; Salivary progesterone; Power motive; Affiliation motive; Menstrual cycle; Oral contraceptives; Relationship status

Implicit motives have been defined as enduring preferences for affectively charged incentives; they develop from socialization experiences in early, preverbal childhood and select, orient, and energize behavior (McClelland, 1987). They are implicit in the sense that they operate outside of a person's conscious awareness and are not correlated with measures of motivational orientations based on self-report (McClelland, 1987; Schultheiss and Brunstein, 2001). However, they can influence an individual's fantasies and behavior if aroused by motive-relevant situational cues. Therefore, the strength of a person's motives can be determined by analyzing the content of fantasies she or he reports in response to picture cues. The Picture Story Exercise (PSE) technique developed by McClelland and colleagues for the assessment of implicit motives is typically used for this purpose (Smith, 1992). Over the past 50 years, researchers have used this technique to identify, assess, and describe implicit motive systems, which include the power motive (a concern for having impact on others or the world at large) and the affiliation motive (a concern for establishing, maintaining, or restoring close, friendly relationships; see McClelland, 1987; Winter, 1996).

Some evidence points to a role of implicit motives in sexual reproduction, as reflected in the formation and maintenance of close, intimate relationships, in mating patterns and success, and in parental investment in offspring. For instance, power and affiliation motivation have been linked

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to relationship satisfaction and discord (Mason and Blankenship, 1987; Stewart and Rubin, 1974; Winter et al., 1977), sexual promiscuity in men (McClelland, 1987), and number of children in women (Peterson and Stewart, 1993). In men, affiliation motivation has been found to correlate with involvement in child rearing (Peterson and Stewart, 1993).

In the present study, we aimed to extend this line of research by exploring for the first time whether menstrual cycle phase affects implicit motive levels in women. Previous research on social behavior across the menstrual cycle in humans has provided less clear-cut cycle-phase effects on motivation and behavior than studies conducted in primates and other mammals (Carter, 1992a). One reason for this inconsistency may be a greater reliance on self-report than on observational or psychophysiological measures in research with human subjects (cf. Schreiner-Engel et al., 1981). Because measures of implicit motivation have been found to correlate with psychophysiological responses (Jemmott, 1987; McClelland, 1987) and to be influenced by situational and endocrine factors (McClelland, 1987; Schultheiss et al., 1999), we expected them to be sensitive to hormonal changes across the menstrual cycle.

We explored to which extent cycle-phase effects on implicit motives depend on naturally occurring hormone changes by comparing a group of normally cycling women to a group of women who used oral contraceptives and a yoked-control group of men during the menstrual, midcycle, and premenstrual phase of the menstrual cycle. We also controlled for relationship status (single versus engaged) as a potential confound of oral contraceptive use. Finally, we assessed participants' levels of salivary estradiol (E), progesterone (P), and testosterone (T) in each cycle phase to test for associations between these hormones and implicit power and affiliation motivation across the menstrual cycle and also specifically for each cycle phase. Recent experimental research has suggested a close link between power motivation and T in men (Schultheiss and Rohde, 2002; Schultheiss et al., 1999), and we therefore expected to obtain a general positive correlation between these measures in male participants. Analyses for female participants were exploratory in this regard, as were all other analyses involving possible relationships between motive and hormone measures in women and men.

Method

Participants and design

Eighteen normally cycling (NC) women, 18 women who were currently taking oral contraceptives (OC) and had used them for at least 6 months (all used estrogen-gestagen combination pills; 17 used monophasic contraceptives and 1 a biphasic contraceptive), and 18 men participated in the study. Only women with stable menstrual cycles of 25 to 31 days during the previous 3 months were admitted. All participants were enrolled as students at the University of Potsdam, Potsdam, Germany. None of the participants reported to smoke, diet, or to be taking antianxiety, antidepressive, or hormonal medication (apart from the oral contraceptives).

Each participant was assessed three times (T1, T2, and T3). In NC and OC women, T1 coincided with the menstrual phase (3 to 4 days after menstruation onset as confirmed by the participants, representing the follicular phase in NC women), T2 with the midcycle phase (12 to 14 days after cycle onset, representing the periovulatory phase in NC women), and T3 with the premenstrual phase (22 to 26 days after cycle onset, representing the luteal phase in NC women), based on a typical (i.e., 27 to 29 days) menstrual cycle. For women with longer (30 to 31 days) or shorter (25 to 26 days) self-reported menstrual cycle durations, scheduled assessment dates were expanded or contracted proportionately. Women were tested in three contiguous cycle phases; however, the initial assessment could take place in any of the three cycle phases (T1, T2, or T3) and the two subsequent assessments then took place during the following two cycle phases. Initial data collection sessions coincided with T1 for 13 women, with T2 for 11 women, and with T3 for 12 women. Based on a hypothetical menstrual cycle of 27 to 29 days, men were scheduled so that the temporal sequence of their testing sessions (T1, T2, and T3) mirrored the phases of women's menstrual cycles. In each phase, participants were assessed in groups of up to four people, but women and men always participated in separate sessions. Information about age and relationship status was obtained at T3. To minimize the effects of diurnal variations on hormone levels, all sessions were held in the afternoon.

In each of the three assessments, participants provided a saliva sample and were administered a Picture Story Exercise. After completing all three sessions, they received 60 Deutschemark (~$30) for their participation.

Implicit motives

Participants' implicit motives were assessed with three parallel PSE sets (A, B, and C) of five pictures each, which were constructed specifically for the purposes of the present study. In each set, the first picture depicted a male-female couple in a relaxed affiliative setting (e.g., at the beach or on a park bench), the second picture showed a person teaching or lecturing in front of a class or audience, the third picture displayed a woman in a position of power over a man (e.g., a woman blindfolding a man), the fourth picture displayed a couple performing a dangerous stunt (e.g., two trapeze artists in midflight), and the fifth picture depicted three people (one or two of them female) interacting with each other in an ambiguous context (e.g., talking on the street). We chose these pictures for their strong power- and affiliation-related character. Some pictures have previously been used by other researchers (e.g., couple on a park bench,

trapeze artists; see Schultheiss and Brunstein, 2001), but most pictures were employed here for the first time.

To prevent a confoundation between picture set and assessment phase, we systematically varied the sequence in which the sets A, B, and C were administered to participants across T1, T2, and T3, resulting in the six sequence permutations, ABC, ACB, BAC, BCA, CAB, and CBA. Each picture set was administered to participants using standard instructions described in Smith (1992). Participants had 5 min per picture to write a story. All stories were later coded for power and affiliation motive imagery according to Winter's (1994) "Manual for Scoring Motive Imagery in Running Text," by a trained scorer who had previously attained over 85% agreement with training materials prescored by experts and which are contained in the Manual. The scorer was blind with regard to participants' cycle phase and group membership. For each motive category, we created (a) a total score across all three sets and (b) separate scores for sets A, B, and C. All scores were converted to motive images per 1000 words to adjust for differences in protocol length. Although the three sets did not differ in the length of the stories written in response to them, set B elicited significantly more power imagery and significantly less affiliation imagery than the other two sets, Ps < 0.05. To correct for these differences, we converted participants' adjusted motive scores to z scores within each picture set. The influence of picture set on participants' motive scores in any given cycle phase was thus removed from the scores' variance. Total scores representing typical motive levels from T1 through T3 were created by summing motive scores and expressing them directly as images per 1000 words.

Hormone assays

Sample collection and processing

In each testing session, participants used a fresh sugar-free chewing gum to collect between 4 and 8 mL of saliva in a sterile polypropylene vial for about 5 min (Dabbs, 1991). Vials were closed and frozen immediately at the end of each session. Samples were freed from mucopolysaccarides and other residuals by several freeze-thaw cycles with subsequent centrifugation. All hormone assays were conducted by using solid-phase Coat-A-Count ^{125}I radioimmunoassays for T (TKTT), 17β-estradiol (TKE), and P (TKPG) provided by Diagnostic Products Corporation Biermann (Bad Nauheim, Germany), and all samples were measured in duplicate for 2 min on a γ-counter (Wallac Oy 1277 GammaMaster) after mixing, incubation, and decanting. Unknown sample concentrations were estimated from the standard curve using the spline algorithm of the counter's software (Wallac 1224 RiaCalc, EG&G Wallac, Turku, Finland). Assay reliability was evaluated by including control samples with known hormone concentrations in each assay (Bio-Rad Lyphochek level I, II, and IIIBio-Rad Laboratories, Hercules, CA). According to validation data supplied by the manufacturer, none of the assays cross-reacts with estrogens and gestagens contained in oral contraceptives.

Testosterone assay

For determination of T levels in male saliva, we conducted one assay according to the protocol described by Campbell et al. (1999). Intraassay coefficient of variation (CV), assessed in participants' saliva samples, was 6.95% and analytical sensitivity (B_0 − 3 SD) was at 0.30 pg/mL. To determine T levels in female saliva, we prepared water-based 1:160 dilutions of all standards (resulting range, 1.25 to 100 pg/mL) and controls. Eight hundred microliters of standards, controls, and samples were pipetted into tubes and 1 mL of tracer was added to each. All tubes were incubated overnight at room temperature. Analytical sensitivity (B_0 − 3 SD) of the assay was at 3.03 pg/mL. Analytical recovery was 107.63%, 90.14%, and 103.91% for low (5.44 pg/mL), medium (28.13 pg/mL), and high (66.88 pg/mL) T concentrations. Intraassay CVs were 8.67%, 6.97%, and 5.39% and interassay CVs were 7.85%, 15.37%, and 2.88% for low, medium, and high controls. Linearity was evaluated by measuring T in a known sample (44.29 pg/mL) diluted 1:2 and 1:4, which yielded recovery coefficients of 95.98% and 124.32%.

Estradiol assay

To determine salivary 17β-estradiol levels, we prepared water-based 1:80 dilutions of all standards (resulting range, 0.25 to 45 pg/mL) and controls. Eight hundred microliters of standards, controls, and samples were pipetted into tubes and 1 mL of tracer was added to each. All tubes were incubated in a waterbath for 1 h at 37°C. Analytical sensitivity (B_0 − 3 SD) was at 0.25 pg/mL. Analytical recovery was 49.83%, 101.45%, 103.45%, and 86.17% for low (0.99 pg/mL), medium (2.28 pg/mL), high (6.01 pg/mL), and very high (Lyphochek level III, fourfold concentration, 24.05 pg/mL) E levels. For these same levels, intraassay CVs were 20.89%, 10.52%, 5.17%, and 2.34%, and interassay CVs were 42.45%, 14.08%, 15.63%, and 8.17%. Analytical recovery was also assessed by spiking a known sample (2.23 pg/mL) with 2.52, 7.32, and 22.50 pg/mL E, yielding recovery coefficients of 114.58%, 92.50%, and 107.67%. Linearity was evaluated by measuring E in a known sample (14.00 pg/mL) diluted 1:2, 1:4 and 1:8, yielding recovery coefficients of 101.51%, 70.40%, and 100.57%.

Progesterone assay

To determine salivary P levels, we prepared water-based 1:80 dilutions of all standards (resulting range, 1.25 to 500 pg/mL) and controls. Four hundred microliters of standards, controls, and samples were pipetted into tubes and 1 mL of tracer was added to each. All tubes were incubated overnight at room temperature. Analytical sensitivity (B_0 − 3 SD) was at 2.45 pg/mL. Analytical recovery was 84.18%, 104.68%, and 100.28% for low (11.88 pg/mL), medium (86.25 pg/mL), and high (228.00 pg/mL) P concentrations.

Table 1
Sample characteristics (mean ± SEM)[a]

	NC women	OC women	Men
Age in years	22.50 (0.66)	21.00 (0.25)	23.00 (0.49)
Power motive	8.07 (0.63)	8.35 (0.74)	8.27 (0.73)
Affiliation motive	8.25 (0.56)	9.97 (0.58)	8.02 (0.77)
Number engaged in close relationship	11	12	12

[a] NC, normal cycles; OC, oral contraceptive users.
For each participant group, $n = 18$. Motive scores represent images per 1000 words, totaled across all three Picture Story Exercise sets.

Analytical recovery was also assessed by spiking two known samples (sample A, 24.68 pg/mL; sample B, 87.63 pg/mL) with low (9.35 pg/mL) and high (87.06 pg/mL) levels of P. For sample A, recovery was at 87.49% and 86.84%, and for sample B, recovery was at 88.31% and 92.83% for low and high levels of added P. For low, medium, and high P controls, intraassay CVs were 41.70%, 8.21%, and 4.88%, and interassay CVs were 19.23%, 14.99%, and 9.47%. Assay reliability was also assessed with samples from a male (24.30 pg/mL) and a female (follicular phase, 24.45 pg/mL) saliva pool. Intraassay CVs were 7.86% and 7.24% and interassay CVs were 5.35% and 1.36% for the male and female samples. Linearity was evaluated by measuring P in sample B, diluted 1:2, 1:4, and 1:8, which yielded recovery coefficients of 81.81%, 78.50%, and 109.04%.

Statistical procedures

All analyses were conducted with SYSTAT 7.1 and SPSS 9.0 and involved regression and correlation analysis, analysis of variance (ANOVA) with post hoc comparisons (Fisher's least significant difference test), repeated-measures ANOVA, and paired *t* tests. Descriptive statistics are given as mean ± SEM. An α level of 0.05 (two-tailed) was employed in all analyses.

Results

Participant characteristics

Although the three groups did not differ in power motivation, a group difference for the affiliation motive approached significance, $F(2,51) = 2.78$, $P = 0.07$ (cf. Table 1). Post hoc comparisons revealed that OC women's affiliation motive was significantly higher than men's, $P < 0.05$, and marginally higher than NC women's, $P = 0.06$. NC women's affiliation motive did not differ from that of men. Although being engaged in a close relationship was negatively correlated with the affiliation motive in the overall sample, $r = -0.37$, $P < 0.01$, covarying out relationship status did not decrease the group differences in participants' affiliation motive; rather, it made the effect fully significant, $P < 0.05$. Further ruling out relationship status as an explanation for OC women's elevated affiliation motive scores, we did not observe any group differences in relationship status.

Although men's T levels were only about two- to threefold higher than those of women (cf. Table 2), both men's and women's T levels fell within the ranges of male and female salivary T recently reported in a multicenter evaluation study (Dabbs et al., 1995: men, 70–126 pg/mL; women T, 13–27 pg/mL). Compared to OC women, NC women had overall higher T, $F(3,32) = 3.20$, $P < 0.05$. NC women's salivary P was well within the ranges reported for each cycle phase in previous reports (Riad-Fahmy et al., 1987: follicular, 0–47 pg/mL; luteal, 94–236 pg/mL; Sufi et al., 1985: follicular, 8–24 pg/mL; luteal, 63–110 pg/mL) and increases from the periovulatory to the luteal phase ranged between 63% and 998%. Consistent with our assay's lack of sensitivity for exogenous gestagens, OC women had overall lower P than NC women throughout the menstrual cycle, $F(3,32) = 11.07$, $P < 0.00005$, and did not display the characteristic luteal peak (T3) observed in NC women. Men's salivary P was comparable to that of NC women in the follicular phase (T1), which is consistent with findings

Table 2
Means (in pg/mL, ± SEM) of salivary hormone concentrations across three assessments[a]

	Testosterone			Estradiol			Progesterone		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
NC women	36.2[b] (4.0)	30.1[b] (2.6)	35.1[b] (3.4)	2.4[b] (0.3)	2.6[b] (0.3)	3.7[c] (0.5)	27.9[b] (2.7)	26.4[b] (2.1)	88.0[c] (13.1)
OC women	25.2[b] (2.1)	26.7[b] (2.6)	23.0[b] (2.2)	1.9[b] (0.2)	1.9[b] (0.1)	2.1[b] (0.4)	21.5[b] (1.8)	25.1[b] (1.8)	21.1[b] (1.9)
Men	72.4[b] (4.0)	74.2[b] (5.4)	73.5[b] (3.6)	2.6[b] (0.2)	2.6[b] (0.3)	3.0[b] (0.6)	24.6[b] (2.2)	22.6[b] (1.3)	22.8[b] (1.9)

[a] NC, normal cycles; OC, oral contraceptive users. For women, T1 corresponds to the menstrual phase, T2 to the midcycle phase, and T3 to the premenstrual phase of the menstrual cycle. For each participant group $n = 18$.
[b,c] Within each group of participants, means sharing the same superscript do not differ at Ps < 0.05 or better.

Table 3
Means (± SEM) of motive measures (*z* scores) across three assessments[a]

	Power motive			Affiliation motive		
	T1	T2	T3	T1	T2	T3
NC women	−0.16[b] (.23)	−0.25[b] (0.23)	0.28[c] (0.14)	−0.29[b] (0.21)	−0.10[b] (0.20)	−0.17[b] (0.25)
OC women	0.18[b] (.23)	−0.19[b] (0.26)	0.12[b] (0.25)	−0.04[b] (0.17)	0.53[b] (0.25)	0.33[b] (0.23)
Men	0.11[b] (.31)	0.15[b] (0.17)	−0.25[b] (0.26)	−0.12[b] (0.21)	−0.24[b] (0.29)	−0.09[b] (0.26)

[a] NC, normal cycles; OC, oral contraceptive users. For women, T1 corresponds to the menstrual phase, T2 to the midcycle phase, and T3 to the premenstrual phase of the menstrual cycle. For each participant group $n = 18$.

[b,c] Within each group, means sharing the same superscript do not differ from each other at Ps < 0.05 or better.

for serum P (Zumoff et al., 1990). While our assay performance data indicated a lack of reliability for salivary E below 1 pg/mL, average concentrations observed in our sample exceeded this threshold two- to threefold and were thus within a measurement range for which we had obtained acceptable analytical recovery and reliability. NC women's salivary E across cycle phases were within the range of salivary E reported by other researchers (Shirtcliff et al., 2000: early follicular, 0.73–1.93 pg/mL; late follicular, 1.52–4.16 pg/mL; late luteal, 0.76–2.12 pg/mL; see also Riad-Fahmy et al., 1987; Sufi et al., 1985) and showed a significant effect of cycle phase, $F(2,34) = 6.06$, $P < 0.01$. Although our prospective method of determining ovulation was too imprecise to reliably capture an E peak in NC women during the periovulatory phase (T2), NC women showed the characteristic elevation in E during the luteal phase (cf. Riad-Fahmy et al., 1987). Paralleling our results for progesterone, OC women were overall lower in E than NC women, $F(3,32) = 3.58$, $P < 0.05$. Although men's salivary E levels were within the range of values reported by Shirtcliff et al. (2000) (0.25–3.93 pg/mL), mean values in our study were higher than those observed by these authors in older men (1.02 pg/mL) and did not differ from those of NC women across all three measurements.

Table 3 shows that while there was no evidence for significant motivational changes in OC women and men, NC women displayed significant changes in the power motive, $F(2,34) = 3.25$, $P = 0.05$. This effect was due to NC women having significantly lower power motivation during the follicular and periovulatory phases (T1 and T2) than during the luteal phase (T3). Because inspection of affiliation and power motive changes across the menstrual cycle suggested similar patterns for NC and OC women, we ran a repeated-measures ANOVA for both groups of women combined, yielding a significant Motive (affiliation vs. power) × Cycle Phase (menstrual vs. midcycle vs. premenstrual) effect, $F(2,70) = 3.50$, $P < 0.05$. Follow-up analyses indicated that women had higher affiliation motivation at midcycle (T2: $M = 0.32$) than in the menstrual phase (T1: $M = -0.17$) and lower power motivation at midcycle (T2: $M = -0.22$) than in the premenstrual phase (T3: $M = 0.20$), Ps < 0.05. Order of testing (i.e., whether subjects were first tested at T1, T2, or T3) did not significantly moderate these effects.

Motive-hormone associations

In testing associations between motive and hormone measures, we followed a two-pronged approach: We first looked at levels of T, E, and P, averaged across all three assessment phases, and tested which motive (total scores across all three assessment phases) would uniquely predict each hormone. This strategy allowed us to examine associations between each individual's *typical* motive and hormone levels. We then looked at relationships between disaggregated motive and hormone measures within and between assessment phases to examine concurrent and cross-lagged effects *specific* to each phase of the female menstrual cycle.

Testosterone

A simultaneous regression of average T levels on overall power and affiliation motive scores with participant group (dummy-coded, with male participants as reference group) held constant revealed a significant unique effect of the power motive on T, partial $r = 0.27$, $B = 1.10$, $SE = 0.56$, $t(1,49) = 1.97$, $P = 0.05$. To illustrate this correlation, we plotted regression slopes separately for each participant group. Although we did not obtain a significant Power Motive × Participant Group interaction, Fig. 1 shows that the direct association between overall power motivation and average T levels tended to be stronger in men than in both NC and OC women. While this may suggest that, in general, the link between power motivation and T found in men may not be as strong in women, we identified relationship status as an important moderator of the power motive-T association in women. In single women, but not in women engaged in a close relationship, the power motive correlated significantly with average T levels, $r = 0.56$, $P < 0.05$. As indicated by a highly significant Relationship Status × Power Motive interaction, regression slopes differed between the two groups, $B = -3.02$, $SE = 1.20$, $t(1, 32) = -2.51$, $P = 0.01$. This interaction was not moderated by oral contraceptive use and it did not emerge for men.

In subsequent analyses we explored whether those associations between the power motive and T that had become significant at the aggregated level could be traced back to assessment phase-specific correlations. For men, all 3 (T) × 3 (power motive) correlation coefficients were positive, and

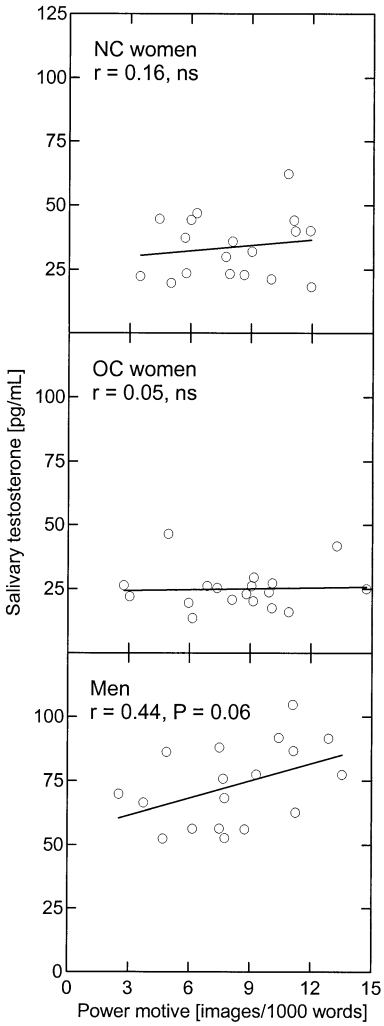

Fig. 1. Regression slopes and correlation coefficients for total levels of power motivation and average levels of salivary testosterone in normally cycling (NC) women, women taking oral contraceptives (OC), and men.

two (T1 and T2 T with T3 power motivation, $r = 0.46$ and 0.47, respectively) became significant, Ps ≤ 0.05. For single women, premenstrual T was significantly correlated with power motivation assessed in the menstrual ($r = 0.65$), midcycle ($r = 0.55$), and premenstrual phase ($r = 0.57$), $P \leq 0.05$, and there was a trend for menstrual T to correlate with menstrual ($r = 0.51$) and midcycle ($r = 0.48$) power motivation, Ps < 0.10. Midcycle T correlations with power motive scores were nonsignificant. For women engaged in a close relationship, 6 of the 3 (power motive) $\times$ 3 (T) correlation coefficients were negative, and only the correlation between menstrual-phase power motivation and premenstrual-phase T became significant, $r = -0.43$, $P < 0.05$.

Estradiol

A simultaneous regression of average E levels on overall power and affiliation motive scores with participant group held constant did not reveal any significant unique effects of participants' motives. We also checked whether the regression slopes differed between groups by including the appropriate interaction terms in the regression equation, but without significant results. Notably, however, we found a significant Relationship Status $\times$ Power Motive interaction among women, $B = -0.335$, $SE = 0.109$, $t(1, 32) = -3.05$, $P < 0.005$, which was not moderated by oral contraceptive use. The effect was due to a significant negative correlation between power motivation and E among women engaged in a close relationship, $r = -0.56$, $P = 0.005$, which did not emerge for single women. More detailed analyses revealed that among women engaged in a relationship, power motive scores and E levels were negatively correlated across all cycle phases and significantly so for menstrual-phase power motivation and menstrual ($r = -0.45$) and premenstrual ($r = -0.57$) E, $P < 0.05$. In contrast, in single women 7 of the 3 (power motive) $\times$ 3 (E) correlations were positive, and menstrual-phase power motivation correlated significantly with menstrual-phase E levels, $r = 0.54$, $P = 0.05$.

Because only NC women showed significant cycle-based variations in both E and implicit power motivation, we also explored the relationships between E and power motive scores across all three cycle phases, but none of the 3 (power motive) $\times$ 3 (E) correlations became significant.

Progesterone

Regression analyses revealed a significant Participant Group $\times$ Affiliation Motive effect on average P levels, $\Delta F(2,47) = 3.81$, $P < 0.05$, above and beyond direct effects of implicit motives and participant group on P. This interaction was largely due to a strong negative association between affiliation motivation and P in men and a marginal ($P < 0.10$) positive correlation in NC women (cf. Fig. 2). Although OC women showed no marked correlation between affiliation motivation and P, it is noteworthy that in OC women low in average E, these variables were strongly correlated, $r(9) = 0.78$, $P = 0.01$, whereas they were uncorrelated in OC women high in average E [for the interaction: $B = -0.184$, $SE = 0.070$, $t(14) = -2.63$, $P < 0.05$].

We carried out more detailed analyses for NC women and men and found that among NC women, 7 of the 3 (affiliation motive) $\times$ 3 (P) correlations were positive and luteal affiliation motivation correlated significantly with periovulatory, $r = 0.49$, $P < 0.05$, and, at a marginal significance level, with luteal P, $r = 0.48$, $P = 0.06$. In contrast, among men, 8 of the 3 (affiliation motive) $\times$ 3 (P) correlations were negative, but only the correlation between P at T1 and affiliation motivation at T2 approached significance, $r = -0.42$, $P = 0.08$.

Because only NC women showed significant cycle-based variations in both P and implicit power motivation, we also explored the relationships between P and power motive scores across all three cycle phases. Only one marginally significant correlation was observed for motive (luteal, T3) and hormone (luteal, T3) levels, $r = -0.42$, $P = 0.08$.

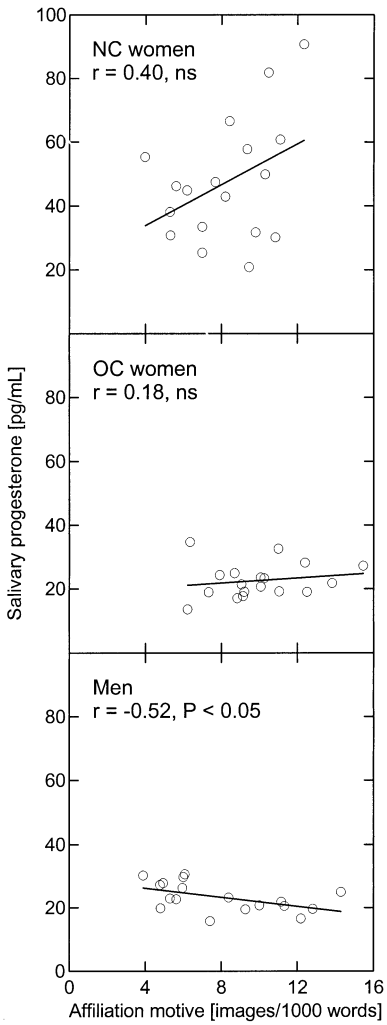

Fig. 2. Regression slopes and correlation coefficients for total levels of affiliation motivation and average levels of salivary progesterone in normally cycling (NC) women, women taking oral contraceptives (OC), and men.

Discussion

The results of this study provide evidence for cycle phase-associated changes in implicit motives. In general, women showed signs of elevated affiliation motivation and attenuated power motivation at midcycle (around ovulation for NC women), which may suggest that due to their comparatively strong need for close, harmonious relationships, paired with a relatively weak desire to assert themselves and have impact on others, they may have been motivationally primed to engage in a new, or intensify an existing, intimate relationship at that time. This motivational state could serve to increase the likelihood of sexual encounters and, in NC women, contribute to conception and reproductive success (cf. Wilcox et al., 1995). In NC women, it may also be associated with the increased coital frequency observed in the late follicular phase (e.g., Adams et al., 1978). Note, however, that cycle-based motivational changes may not be solely driven by concurrent hormonal changes, but can also be based on other factors, such as entrainment of motivational states through past cycle-based hormone changes. This notion is supported by our observation that while cycle-based motive changes were most pronounced in NC women, they also tended to occur in OC women who, due to their use of mostly monophasic hormonal contraceptives, had steady levels of overall estrogen and progesterone throughout their cycles.

With regard to associations between overall motive and hormone levels, averaged across assessment phases, we obtained a number of intriguing findings. First, as predicted, higher levels of T were associated with higher levels of power motivation. This association was stronger in men than in NC women or OC women. However, we identified relationship status as an important moderator of the power motive-T link in women: in single women, but not in women currently engaged in an intimate relationship, we found a strong positive correlation between the power motive and T. Although no straightforward causal inference can be made at this point due to the cross-sectional nature of the measures involved, this may suggest that being engaged in a close relationship may keep women from successfully exerting power and thus prevent the T increases presumably associated with such impact experiences (cf. Schultheiss et al., 1999). This view of relationship commitments as a potential source of stress for high-power women may also be supported by our observation that in engaged women, high power motivation was associated with low levels of E, a hormone subserving sexual motivation and receptivity (Carter, 1992b). While future research must investigate the causes for this pattern of findings in women engaged in a relationship, our results for single women provide initial evidence that the link between the power motive and T previously established for men (Schultheiss and Rohde, 2002; Schultheiss et al., 1999) also emerges in women.

Furthermore, we found a relationship between the affiliation motive and P that was strong and negative for men and moderate and positive for NC women, while no substantial overall correlation between the two variables could be observed in OC women. Detailed analyses revealed that in NC women, the positive motive-hormone correlation was particularly pronounced for periovulatory and luteal P and luteal affiliation, suggesting that P may prime a temporary increase in the need for close, harmonious relationships, and possibly sexual contact, during a phase of the cycle in which an egg may be fertilized and become implanted in the uterine wall. Regarding the functional role of such a priming mechanism, we suggest that in women, P may facilitate behaviors aimed at establishing or solidifying social bonds with a partner (and potential father of the child) and one's extended social group and thus ensure adequate support throughout a pregnancy. To further evaluate the validity of this explanation, it would be informative to study changes in affiliation motivation over the course of pregnancy, which is characterized by a steep P increase (cf. Fleming et al.,

1997). A priming effect of P on female affiliation motivation may also explain the elevated levels of overall affiliation motivation observed in OC women. Since most oral contraceptives are either a combination of estrogens and gestagens or based on gestagens entirely, their use may result in artificially prolonged and heightened levels of gestagens in the body (which were not detectable by the assay used), which in turn may induce increased levels of affiliation motivation.

Obviously, however, our priming hypothesis cannot account for the negative correlation between P and affiliation motivation in men. Our interpretation of this finding rests on the antiandrogenic properties of P in men, which are particularly evident in the libido-decreasing effects of progestogens in the treatment of male sex offenders (Cooper, 1986). We suggest that the affiliation motive reflects to some extent sexual motivation, which would explain why in men high levels of libido-depressing P are associated with low levels of affiliation motivation. Clearly, however, further research is needed to test the validity of this hypothesis.

One potential problem for the interpretation of our results stems from the fact that our assays did not measure total (i.e., of endogenous and exogenous origin) levels of bioavailable estrogens and gestagens in OC women, but only endogenously produced E and P. Thus, what do the E and P measurements we obtained in OC women represent and can they validly predict anything? Although we are not aware of any study in which endogenous E and P levels before the onset of OC use had been correlated with endogenous E and P levels after onset, we suggest that individual differences in typical endogenous E and P levels will be preserved during the use of OC, albeit at a lower overall level and without the peaks of E around ovulation and P in the luteal phase characteristic of a normal cycle. In fact, we found P and E to be relatively stable in OC women from one assessment phase to the next, with test-retest correlations ranging between 0.22 and 0.63 for E and 0.14 and 0.31 for P. Thus, with everything else being equal, we assume that average endogenous ovarian steroid levels in women taking OC can still have predictive validity, as indicated, for instance, by the substantive correlation between E and power motivation among engaged women (consisting of contraceptive users and nonusers). Still, it remains an open question whether we would have obtained stronger motive-hormone correlations in OC women had we been able to assess total E and P levels or even to partition these levels into endogenous and exogenous portions.

To sum up, our findings indicate that motive levels in women covary with cycle stage, relationship status, and possibly with OC use. Since we do not know at this point whether and how these variables may influence the predictive validity of implicit motive measures, we recommend their assessment as potential control or moderator variables in future studies on implicit motivation. It is noteworthy in this context that our data suggest that the relatively higher levels of affiliation motivation in women, compared to men, obtained in many studies may be related to the use of OC (e.g., Schultheiss and Brunstein, 2001; Stewart and Chester, 1982). Moreover, researchers who are interested in testing the effects of situational and motivational variables on gonadal steroid hormones in women should bear in mind that OC downregulate normal steroid release in the ovaries (as indicated by the attenuated T, E, and P levels observed in OC women) and may thus interfere with normal endocrine responses to motivationally arousing stimuli. We therefore recommend treating OC use as an independent variable or excluding OC users from samples in this type of research. Finally, researchers should also keep in mind that NC women may be differentially sensitive to motivationally arousing stimuli during different stages of the menstrual cycle and that relationships between motives and hormonal parameters may change across the cycle. Determination of cycle phase, be it through self-report or physiological methods, is therefore a must in future studies on the psychoendocrinology of implicit motives in women and strongly recommended for other types of motive research.

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