Nonconscious Processing of Sexual Information: A Generalization to Women

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Sexually competent stimuli may nonconsciously activate sexual memory and set up sexual responding. In men, subliminally presented sexual pictures facilitated recognition of sexual information (Spiering, Everaerd, & Janssen, 2003). The goal of the two experiments reported here was to investigate to what extent this result can be generalized to women. A direct replication in women failed in Experiment 1. In Experiment 2, besides the male-oriented sexual picture set, pictures of two other sets were presented: female-oriented sexual pictures and baby pictures. Effects of the menstrual cycle were also examined. In Experiment 2, only male-oriented pictures showed a facilitation effect. Sensitivity for reproductive stimuli was enhanced during the midluteal phase. Like men, women may nonconsciously recognize a stimulus as sexual. This recognition process seems unrelated to the potential of the stimulus to elicit subjective arousal.

Activation of sexual response may be largely determined by nonconscious cognitive processing. The subjective experience of sexual arousal certainly depends on conscious processing, the individual's awareness of bodily sensations together with the appraisal of the response as sexual. Yet this subjective experience can be seen as contingent on cognitive processing outside of awareness. Sexual stimuli may be recognized nonconsciously; autonomic responses as well as motor programs may be activated by efferent messages from implicit sexual memory. Two studies (Janssen, Everaerd, Spiering, & Janssen, 2000; Spiering, Everaerd, & Janssen, 2003) have found empirical support for this view; however, only male participants were included. The goal of the experiments reported here was to investigate to what extent these results could be generalized to women.

In the production of a sexual response, stimuli that are appraised as sexual are transformed into specific messages. Emotion theories and theories about the role of different memory systems can be applied to clarify this activational process. Long-term memory is not a unitary entity, but can be subdivided into explicit (or declarative) and implicit (or procedural) memory (Squire, 1992; Tulving & Schacter, 1990). Explicit memory is consciously accessible; implicit memory is not. Regarding "sexual memory" - that is, memory associated with sexual responding - explicit memory refers to, for instance, recollections of sexual encounters, attitudes toward sex, sexual fantasies, and knowledge about sexual rewards or costs. Implicit sexual memory refers to, for instance, innate sexual reflexes, learned sexual scripts, and classically conditioned sexual responses. Explicit memory is connected with the experience of sexual excitement and implicit memory to the physiological components, such as sexual arousal (Geer, Lapour, & Jackson, 1993).

The coming about of an emotional response can be conceived as the result of two independent processes (LeDoux, 1996, 2000). The core of the emotional system involves a mechanism for computing the affective significance of stimuli (cf. Zajonc, 1984). This mechanism depends on implicit memory and operates automatically and outside of conscious awareness. The second process is dependent on explicit memory and involves conscious elaboration of emotional information. In the field of sex research, Janssen et al. (2000) recently proposed a theoretical model wherein different levels of cognitive processing differentially affect subjective and physiological components of sexual arousal. Physiological sexual arousal is activated automatically when a relevant stimulus matches with implicit sexual memory. Through an attentional process associated with explicit memory, a subjective experience of sexual arousal is constructed. To test this model, different experiments were conducted using a priming paradigm (Janssen et al.; Spiering et al., 2003; Spiering, Everaerd, & Elzinga, 2002; Spiering, Everaerd, & Laan, 2004).

Priming involves a change in the ability to identify a stimulus as a consequence of a prior encounter with a related stimulus. This type of paradigm can be used to study the independent contributions of implicit and explicit processes (Schacter & Badgaiyan, 2001; Schacter & Buckner, 1998). An accepted operational definition of implicit processes is evidence for indirect effects of a stimulus in the absence of direct effects (e.g., Greenwald, Klinger, & Schuh, 1995), or in other words, when priming

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stimuli produce a response without being consciously elaborated.

In experiments of Janssen et al. (2000) and Spiering et al. (2003), male participants were asked to categorize sexual and neutral "target" slides as quickly as possible. Targets were preceded by subliminally presented sexual or neutral "prime" slides. As predicted, sexual primes facilitated the recognition of subsequent sexual targets. Because the primes were held inaccessible to conscious elaboration, this facilitation effect provides evidence for the activation of implicit sexual memory. Regarding subjective arousal, no effect of prime presentations was found. This suggests that explicit memory was successfully bypassed. Also, participants did not report having noticed the presence of the primes during the exit interview. In these experiments, only men were tested, with the objective of maximizing priming effects. Men, as compared to women, become more easily aroused by visual stimuli (Geer et al., 1993). Ergo, it is an important question to what extent the results can be generalized from men to women.

It can be surmised that implicit processing of sexual information is similar for both genders and that gender differences merely exist in explicit sexual memory. The association between genital vasocongestion and subjective sexual arousal is stronger in men compared to women (Laan & Everaerd, 1995). This could be explained by independent contributions from explicit and implicit memory. The subjective experience of sexual arousal is more blended with other emotional experiences in women compared to men (Everaerd, Laan, Both, & Van Der Velde, 2000). A sexual stimulus may activate a broader set of meanings in explicit memory in women, such as relationship-oriented meanings (Geer, 1996).

From an evolutionary perspective, Bjoklund and Kipp (1996) stated that women are better able to inhibit sexual responses. Dissimilarities between prehistoric gender roles may have influenced information-processing mechanisms. Men have been selected to maximize their mating opportunities, whereas women do not benefit by increasing the number of sexual partners and would risk producing offspring of low quality when they mated indiscriminately (Bailey, Gaulin, Agyei, & Gladue, 1994). Inhibition may occur by attentional mechanisms that bring explicit memories into awareness. Consequently, the greater inhibitory capacity of women might be due to a gender difference in explicit memory, while the initial, implicit, stage of activation is similar for both genders.

The argument above is speculative. Data from a recent fMRI study on gender differences in emotional memory showed a more complex picture (Canli, Desmond, Zhao, & Gabrieli, 2002). In women, activation in more brain regions correlated with ongoing emotional experience compared to men. This could not be attributed to differences in explicit memory only. Also, when implicit activation develops by (extensive) learning (e.g., automatization), culturally generated gender differences may bring about gender differences in implicit memory.

EXPERIMENT 1

Experiment 1 was a direct replication, in women, of the male study (Experiment 1, Spiering et al., 2003). To test whether sexual meaning can be activated implicitly, we asked participants to respond to consciously-perceived sexual and neutral targets that were preceded by subliminally-presented sexual and neutral primes. The experiment consisted of two series of trials. In the first series, we assessed whether sexual primes can activate implicit sexual memory and thus facilitate the recognition of sexual targets. In the second series, we tested whether sexual primes, when rendered inaccessible to conscious awareness, will fail to elicit subjective sexual arousal.

Method

Participants

Thirty female university students (*M* = 21.5 years, *SD* = 2.9) participated in this study. As only heterosexual stimulus materials were used, only heterosexual women were recruited. All participants completed written informed consent prior to participation and were offered course credits for collaboration. All participants reported being sexually active and relatively satisfied with their current sexual life (*M* = 3.4, *SD* = 1.0, on a 5-point scale from *highly dissatisfied* to *highly satisfied*).

Materials

Since all settings, materials, and procedures were kept identical compared to the male study (Experiment 1, Spiering et al., 2003), we only present a brief description here.

The experiment was conducted in two adjacent rooms. Participants were seated at a table facing a backlit milk-colored projection screen. For the registration of responses, three button boxes were placed in front of the participant. The first button box was placed in the middle of the table. This box had seven buttons and was used to measure subjective responses on a 7-point scale. Two boxes with one button each were used to measure decision times. They were placed on the left and right side of the table. One was labeled with the word *sex*, the other with the word *plant*. The positions (left or right) of these buttons were randomized across participants. The experimenter and all technical equipment needed for slide presentations and data collection was stationed in the other room. The experimenter communicated with the participant using an intercom system.

The neutral or *plant* slides depicted flowers, plants, and bushes. Slides with sexual content were made of photographs taken from erotic magazines. We created two subsets of male-oriented sexual stimuli, named *explicit* and *models*. Slides in the explicit subset portrayed heterosexual couples engaging in oral sex or sexual intercourse. These were typical male-oriented pornographic slides with genitals of both sexes clearly visible.

Slides in the models subset depicted nude or nearly-nude women looking into the camera. We discussed mirroring the content of these slides by replacing the nude women by nude men and decided not to do so. In line with the work of Money and Ehrhardt (1972; projectification vs. identification), we hypothesized that in women, same-sex pictorial stimuli will not inhibit sexual arousal to the same degree as in men. Although we are not sure if this hypothesis is correct (empirical research is sparse), we concluded that from a methodological perspective, a direct replication leaving all the variables constant (expect gender) seemed most suitable.

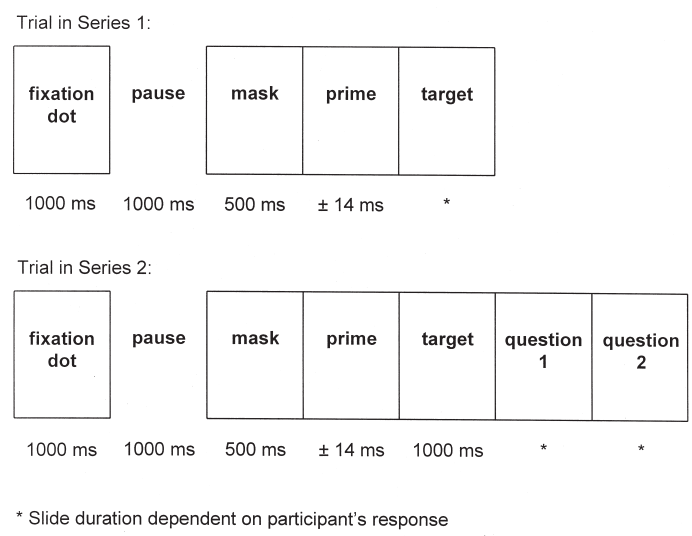
To ensure that these slides were comparable in arousal value and to enable us to attribute small differences in subjective arousal to the different prime categories, we conducted a pilot study in which 23 men rated an initial set of 80 slides. The question "To what degree did you find the last slide sexually arousing?" could be answered on a 7-point scale, varying from *not at all* to *extremely*. We selected 20 slides with a mean of 2.9 (SD = 1.2) to form the models subset. For this study we asked 24 women to rate the slides. Mean arousal was lower compared to men, M = 1.5 (SD = 0.8).

Each of the two stimulus series consisted of 40 trials. In each trial a consciously-perceived sex or plant target was preceded by a subliminally-presented sex or plant prime. In the first series, decision time was the dependent variable. We asked participants to categorize the targets as quickly as possible by pushing either the sex or plant button. We measured decision time from onset of the target to the pressing of a button. In the second series, the variable of interest was subjective sexual arousal. Each target was followed by two questions. The first asked participants to indicate how sexually aroused they felt: "To what degree did you feel sexually aroused at this moment?" Participants could press one of the seven buttons, reflecting a 7-point scale with *not at all* and *extremely* as its anchors. Since we generally expected low levels of sexual arousal and since the possibility of carry-over effects existed (i.e., participants still experiencing arousal from a previous slide), a second, more indirect and evaluative assessment of sexual arousal was added. This involved a rating of the arousal value of the slide and required participants, using the same 7-point scale, to answer the question, "To what degree did you find the last slide sexually arousing?"

In addition to the sex and plant slides, we used four other slides. First, a black fixation dot signaled the start of each trial. Second, before each prime presentation, we presented a mask. The mask was constructed by arranging pieces of photographs of neutral objects (e.g., trees, musical instruments) and parts of the human body (e.g., hands, ears) in random orientations. We carefully chose the size and shape of these pieces to prevent recognition of any of the objects presented. Finally, the two questions following the targets in Series 2 were also presented on slides.

Experimental trials proceeded as follows (see Figure 1). First, we presented the fixation dot for 1,000 ms. Then, after

Figure 1. Proceedings of experimental trials.



a delay of 1,000 ms, we presented the mask for 500 ms, directly followed by the prime. We determined prime exposure duration with an identification threshold procedure. Backward masking of the prime was accomplished by immediately presenting the target. Since there was no pause between prime and target, the stimulus onset asynchrony (SOA) was equal to the prime presentation time. In Series 1, we ended target presentations as soon as the participant pressed a button. After 1,000 ms, the next trial was started. In Series 2, we presented targets for 1,000 ms, followed by the slide with the first question. After the participant responded, we presented the second question. As soon as the participant pressed a button, the question disappeared, and the next trial was started 1,000 ms afterwards.

The experimental design of the study was a 2 (Prime: sex, plant) X 2 (Target: sex, plant) within-subjects factorial. Randomization of conditions was limited for both methodological and technical reasons. We created one sequence that consisted of 80 trials. This sequence was randomly determined with one restriction: within each block of 20 trials, the four conditions were equally represented (i.e., each block contained five trials of each of four conditions: sex-sex, sex-plant, plant-sex, plant-plant). We created a mirror of this sequence by changing prime content so that whenever a target was preceded by a sexual prime in the original sequence, it would be preceded by a plant prime in the mirror sequence, and vice versa. These two sequences were randomly distributed among the participants.

Regarding randomization of slides (i.e., the specific slides that fill in the conditions), we used a random selection of 40 out of a total of 80 plant slides as primes; the other 40 were used as targets. We used 20 of the 60 explicit sexual slides as targets in Series 1; the other 40 were used as primes (20 in Series 1, 20 in Series 2). We selected the set of 20 models slides to function as targets in Series 2. We made one random sequence of the targets used for all participants; the sequence of the primes was randomized afresh for each participant.

Procedure

A female experimenter tested all participants individually. The experiment, which took about 75 minutes to complete, consisted of five phases total: (a) adaptation, (b) threshold determination, (c) Series 1: measurement of decision times, (d) Series 2: measurement of subjective sexual arousal, and (e) a forced-choice recognition test (see Table 1). At the end of the experimental session, the participants answered questions in written form about biographic variables, sexual experience, and sexual problems. We also conducted an exit interview and provided participants with information about the theoretical background of the study.

Phase 1: Adaptation. The adaptation phase was included to permit habituation to room illumination level and to the light emitted by the slide presentations, and to familiarize participants with the slide presentation procedure. Participants were presented with 15 slides (including both sex and plant slides), each lasting 30 seconds. They were instructed simply to watch the slides and were told that later in the experiment, some questions might be asked about the slides.

Phase 2: Threshold determination. The longest stimulus (or prime) duration at which a participant was not able to identify or guess correctly the content of slides was considered to be her perceptual threshold. In addition to sex and plant slides, we used stimuli with other affective (e.g., snakes, babies) or neutral (e.g., houses, utensils) content. The sequence of events for a trial in the threshold determination procedure differed in one aspect from an experimental trial: the presentation of the target was now replaced by a second presentation of the mask. After each trial, we asked participants to report anything they saw on the slide between the repeated presentations of the mask. When the participant reported having seen nothing, she was encouraged to try to report on any irrelevant feature of the stimulus that she might have perceived (e.g., shapes, colors). We classified a stimulus as identified when the participant correctly mentioned relevant features of the stimulus. We classified a stimulus as not identified when the participant failed to give any verbal description of the stimulus or when a description was erroneous beyond doubt.

We determined identification thresholds with a combination of the descending (Marcel, 1983) and ascending (e.g., Carr, McCauley, Sperber, & Parmelee, 1982) method of limits (Janssen et al., 2000; Spiering et al., 2003). In the first trial, we set the SOA to 100 ms. When the participant correctly identified the stimulus, the SOA of the next trial was decreased by 10 ms. This was repeated until the participant failed to identify a stimulus for the first time. After this procedure, we held exposure duration constant for the next presentation. When the participant identified the stimulus correctly, the SOA in the next trial was again decreased by 10 ms. When the participant failed to identify the stimulus, we held exposure duration constant. This procedure was repeated until the participant failed to identify five stimuli at the same duration in succession. Then we increased the SOA by 5 ms. When the participant failed to identify five stimuli in succession at this duration, this SOA was considered to be her personal threshold. When, however, the participant did identify a stimulus at this SOA, her personal threshold estimate equaled the exposure duration of the previous block of trials (i.e., 5 ms less). The SOA in the experimental series was set on 80% of the personal threshold.

Phase 3: Series 1, measurement of decision times. We explained to participants that in this phase, only sex and plant slides would be presented, and that they would be

Table 1. Experimental Design of Experiment 1

	Phase 1: Adaptation	Phase 2: Threshold	Phase 3: Series 1	Phase 4: Series 2	Phase 5: Recognition
Goal:	Adaptation to setting, light, slides, etc.	To establish perceptual thresholds	To measure implicit activation of sexual memory	To measure if explicit memory is bypassed	To check if primes were presented subliminally
Task:	Just watch the slides	What is on the slide?	Is it a sexual or a plant slide?	(1) How aroused are you? (2) Is the slide arousing?	Did you see this slide before?
Slides:	Sexual & other affective, plants & other neutral	Fixation dot, mask, sexual & other affective, plants & other neutral	Fixation dot, mask, sex - explicit, plants	Fixation dot, mask, sex - explicit (primes), sex - models (targets), plants, question 1 & 2	Sex - primes, sex - distractors, plant - primes, plant - distractors, fillers
Dependent variable:	None	Individual threshold	Decision time	Subjective sexual arousal	Hit rate

preceded by the fixation dot and the presentation of "the slide with the fragments of photographs" (i.e., the mask). We asked participants to decide in each trial whether the target was a sex or plant slide and to press the corresponding button with their right or left forefinger. They were instructed to respond as quickly and accurately as possible. During a block of 12 practice trials, participants became familiar with the task. After these trials, they were told that the 40 experimental trials would begin.

Phase 4: Series 2, measurement of subjective sexual arousal. After a 5-minute resting period during which participants listened to music, we presented a new block of trials. We informed participants that they would be exposed to a similar series of trials. This time we asked them to answer the two sexual arousal questions after each slide presentation. They could give answers by pushing one of the seven buttons on the box in front of them. We explained that reaction times would not be measured during this series. Six practice trials preceded the block of 40 experimental trials.

Phase 5: forced-choice recognition test. Immediately following the last experimental phase, we started a forced-choice recognition test. We presented a selection of 20 primes again, randomly intermixed with 20 distractor stimuli. We randomly selected five sex and five plant prime slides from Series 1 and five sex and five plant primes from Series 2. The distractor stimuli consisted of 10 sex and 10 plant slides that were matched for content, composition, and luminance. To minimize response biases, we added 20 slides (*fillers*) that participants had consciously perceived earlier during the adaptation phase and the practice and experimental trials. For each slide, participants were asked whether or not they believed they had seen it before. After the participant responded, she was shown the next slide.

Results

Threshold Determination and Recognition Test

Identification thresholds ranged from 10 to 20 ms with a mean of 14 ms (*SD* = 4). The mean SOA in the experimental series was 11 ms (*SD* = 3). In the exit interview, none of the participants reported having seen presentations of a slide between mask and target in the experimental series.

We determined accuracy of the old-new decisions obtained during the recognition task by calculating hit rates (true positive rates), false alarm rates (false positive rates), and positive and negative predictive values (Janssen et al., 2000; Weinstein & Fineberg, 1980). Hit and false alarm rates provide information about accuracy in terms of *detection*, the proportion of stimuli that is correctly or incorrectly identified as prime. Positive and negative predictive values provide information about accuracy in terms of *discrimination*, the proportion of "seen before" and "not seen before" responses that corresponds to primes and distractors. Positive predictive values were calculated as the number of times a subject decided "seen before," given that the stimulus was a prime. This value reflects the probability of a correct response when participants indicate they have seen a slide before. Negative predictive values were calculated as the proportion of correct decisions given the response "not seen before."

The mean hit rate for the *fillers* (i.e., slides that were presented before at a conscious level) was .67 (*SD* = 0.10). Regarding the priming stimuli, the relatively low hit rates indicate that the subjects were not accurate in detecting them (see Table 2). False alarm rates were also low, suggesting that the subjects accurately detected distractors. The combined results indicate that the decision "not seen before" prevailed regardless of the true nature of the presented stimuli.

The positive predictive value for both sexual and neutral stimuli was about .50, indicating that the response "seen before" was given equally as often for primes as for distractors. The positive predictive value for neutral stimuli was relatively high; however, a one-group *t*-test showed there was no significant deviation from chance, $t(28) = 1.85$, $p = .07$ (an alpha level of .05 was used for all statistical tests). Predictive values negative were all about .50, indicating that the response "not seen before" was given equally often for primes as for distractors.

Decision Times

Within a total of 1,200 trials, participants made 15 response errors, *M* = 0.5, *SD* = 0.7 (i.e., participants pressed the sex-button in response to a plant-target and vice versa). Table 3 shows means and standard deviations of errors per condition. A Friedman test, $c^2(3, N = 30) = 0.85$, $p = .84$, revealed no significant differences.

For the remaining 1,185 trials, we eliminated outliers using the following procedure. First, we excluded decision times below 100 ms and above 1,000 ms. Second, we removed decision times of three standard deviations above a participant's mean (cf. Janssen et al., 2000; Mogg, Mathews, & Eysenck, 1992; Ratcliff, 1993; Spiering et al., 2003). This procedure led to the exclusion of another 10 trials. Participants' mean decision times over all 40 trials varied between 312 and 549 ms (*M* = 418, *SD* = 58; see Table 3). A 2 (Prime: sex, plant) X 2 (Target: sex, plant) repeated-measures ANOVA with decision time as the

Table 2. Mean Number and Accuracy of Old-New Decisions in Recognition Task (*N* = 30)

	Sexual		Neutral		Sexual & Neutral	
	Primes	Distractors	Primes	Distractors	Primes	Distractors
Decision "Seen before"	1.8	2.2	2.4	1.5	4.3	3.7
Decision "Not seen before"	8.2	7.8	7.6	8.5	15.7	16.3
	M	*SD*	*M*	*SD*	*M*	*SD*
Hit rate	0.18	(0.19)	0.25	(0.18)	0.22	(0.13)
False alarm rate	0.22	(0.17)	0.15	(0.12)	0.19	(0.12)
Predictive value positive	0.43	(0.31)	0.61	(0.31)	0.55	(0.23)
Predictive value negative	0.49	(0.07)	0.53	(0.07)	0.51	(0.05)

dependent variable revealed no significant main effect of Prime, $F(1, 29) = 2.70$, $p = .11$, and a significant main effect of Target, $F(1, 29) = 24.96$, $p = .00$, indicating slower decisions after neutral targets. Contrary to our prediction, no significant interaction of Prime x Target was found, $F(1, 29) = 2.01$, $p = .17$.

We explored the relationship between the results of the recognition test and the effects of priming using correlational analyses. We calculated Pearson product-moment correlations between an index of "recognition" and an index of "effect of priming" (cf. Janssen et al., 2000; Spiering et al., 2003). We created the index of recognition by multiplying predictive values positive by the associated hit rates. Thus, this index consisted of weighted positive predictive values. We created the effect of priming index by subtracting responses obtained in the congruent trials from responses obtained in the incongruent trials. The correlations between the two indices were $r = -.39$, $p = .04$ for the sexual stimuli and $r = -.05$, $p = .79$ for the neutral stimuli.

Subjective Sexual Arousal

The mean response to the first question ("To what degree did you feel sexually aroused at this moment?") varied from 1.0 to 3.5 ($M = 1.6$, $SD = 0.7$). For the second question ("To what degree did you find the last slide sexually arousing?"), the range was 1.0 to 2.6 ($M = 1.7$, $SD = 0.5$). The correlation between the two questions was $r = .76$ ($p = .00$). Means and standard deviations per condition are presented in Table 3.

A 2 (Prime: sex, plant) X 2 (Target: sex, plant) repeated-measures ANOVA was performed with the first question as the dependent variable. We found no main effect of prime, $F(1, 29) = 0.10$, $p = .92$. The main effect for Target was significant, $F(1, 29) = 17.32$, $p = .00$; sexual targets elicited more arousal compared to neutral targets. We found no significant interaction between the factors, $F(1, 29) = 1.32$, $p = .26$. A 2 (Prime: sex, plant) X 2 (Target: sex, plant) repeated-measures ANOVA with the second question as the dependent variable revealed the same pattern: no main effect for Prime, $F(1, 29) = 0.25$, $p = .62$ and a main effect for Target, $F(1, 29) = 47.82$, $p = .00$, indicating higher arousal ratings after sexual targets and no significant interaction effect, $F(1, 29) = 0.71$, $p = .41$.

To investigate a possible relationship between priming effects and the level of awareness, we correlated the recognition index with the effect of priming. The priming index was created by subtracting responses obtained in the incongruent trials from responses obtained in the congruent trials. The correlations between the two indices were not significant: first question, sexual stimuli $r = -.03$ ($p = .87$), neutral stimuli $r = .19$ ($p = .31$); second question, sexual stimuli $r = .13$ ($p = .51$), neutral stimuli $r = -.03$ ($p = .89$).

Table 3. Mean Decision Time (in ms), Errors in a Categorization Task (Series 1), and Subjective Responses (Series 2) for Sexual and Neutral Targets by Prime Content in Experiment 1 (*N* = 30)

	Series 1				Series 2			
	Decision Time		Errors		Question 1 subjective arousal		Question 2 arousability of slides	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sexual targets								
Sexual primes	408	(61)	0.17	(0.38)	1.7	(0.8)	2.2	(0.9)
Neutral primes	406	(61)	0.10	(0.31)	1.7	(0.8)	2.2	(0.9)
Neutral targets								
Sexual primes	435	(64)	0.13	(0.35)	1.4	(0.6)	1.1	(0.2)
Neutral primes	423	(57)	0.10	(0.31)	1.4	(0.6)	1.1	(0.2)

Discussion

From different findings it can be concluded that the primes were not consciously elaborated and that explicit memory was not activated. Positive predictive values obtained in the recognition test showed no significant deviation from chance. Regarding Series 2, with subjective arousal as a dependent variable, no effects of sexual primes were found. Also, participants did not report noticing the presence of the primes during the exit interview. However, sexual primes did not facilitate the recognition of sexual targets in Series 1 like they did in men (Janssen et al., 2000; Spiering et al., 2003). Sexual information, inaccessible for conscious elaboration, failed to activate implicit sexual memory.

Different interpretations are possible. Women may not recognize visual sexual stimuli nonconsciously like men, and there may be a gender difference regarding the implicit stage of activation. Alternatively, differences between the male and female study could be responsible for the null results reported. Although the study was an exact replication of the male study, two interrelated aspects could be critical: (a) "depth of processing" of the primes differed between men and women and (b) the sexual slides were male-oriented.

Comparison of these data with the male study (Spiering et al., 2003) could justify different levels of processing. Positive predictive values did deviate from chance in the male study, but not in this experiment. It could be hypothesized that perceptual thresholds for the male-oriented explicit sexual slides differed between men and women. The threshold determination procedure resulted in a mean SOA that only differed 1 ms from the male study. However, sexual slides are only a minor part of all the slides that have been used in the threshold determination procedure. The facilitation effect of sexual primes in the male study could have resulted from a lower perceptual threshold of men for the explicit sexual slides in comparison to the other slides used in the threshold determination procedure. The perceptual threshold of women for explicit sexual slides could be roughly the same as for the other (affective) slides used in the threshold determination procedure, and the derived SOAs (i.e., 80% of the personal threshold) could be too low to produce any effects.

Things become more complex when we considered the significant negative correlation between recognition test and Series 1: the "priming effect" decreased with higher levels of recognition. In the male study (Spiering et al., 2003), a significant *positive* correlation was found. Also, a main effect of Target was found in that sexual slides were categorized faster than neutral slides. This effect was absent in the male study. Together these different results may indicate a difference in appraisal of the male-oriented explicit slides by women compared to men.

Data of a similar study may be relevant here. Conscious appraisal of different slide sets was examined: male-oriented, sexually explicit stimuli versus female-oriented, sexually "romantic" stimuli (Spiering et al., 2004). The same paradigm was used, only now primes were presented for 1,000 ms. No gender differences were found in the categorization task and on responses to the first question (subjective arousal). Regarding the second question (arousability of slides), an interaction of slides with gender was found. Women rated targets as less arousing when they had been preceded by explicit primes than did men; no gender difference was found after romantic primes. It was concluded that basic cognitive processing of sexual information is similar for both genders and gender differences merely exist in explicit sexual memory, since this is critical for conscious evaluation of sexual information. Together with the results of the present experiment, this conclusion may be premature, and women might already appraise sexual stimuli differently in an initial, implicit stage of responding.

Öhman and Soares (1994) subliminally presented pictures of snakes and spiders to snake-fearful and spider-fearful participants. Snake-fearful participants showed enhanced SCRs to snake stimuli and spider-fearful participants to spider stimuli (cf. Öhman, Flykt, & Esteves, 2001). A preattentive analysis of emotionally-relevant features was sufficient to elicit a fear response, and more importantly, brief presentations of emotional slides did not seem to prevent a relatively specific analysis of content. The data suggest that snake- and spider-fearful participants were sensitized specifically to the feared stimulus. When emotions are action sets (Frijda, 1986), which imply a set of goals, it could be suggested that implicit processing of stimuli is dependent on their relevance for the current goals of the individual. Regarding the sexual response, these goals might differ between genders, e.g., relationship-oriented features may be more connected to sexual memory in women (Geer, 1996), both explicitly and implicitly.

We decided to replicate the categorization task with the addition of a slide set of female-oriented, romantic sexual stimuli. In addition, there is another variable we would like to control. Apart from psychological factors, sensitivity of the sexual system is dependent on biological factors, e.g., the androgen hormones, estrogen, and progesterone (e.g., Kimura & Hampson, 1994; Slob, Bax, Hop, Rowland, & Van Der Werff Ten Bosch, 1996; Van Lunsen & Laan, 1997). Several studies reported effects in the processing of sexual information across the menstrual cycle (Johnston & Wang, 1991; Krug, Pietrowsky, Fehm, & Born, 1994; Krug, Plihal, Fehm, & Born, 2000; Wang & Johnston, 1993). It might be the case that the chance to find the relatively small implicit effect can be optimized by testing women in a specific menstrual phase.

Three menstrual phases can be distinguished: (a) the menses, when estrogen and progesterone levels are at minimum, (b) the ovulatory phase, with maximum estrogen and androgen but low progesterone, and (c) the midluteal phase, when estrogen is moderately enhanced and progesterone at maximum. In an experiment conducted by Krug et al. (1994), women were asked to categorize briefly-presented sexual and other affective and neutral visual stimuli. No stimulus-specific changes occurred in women taking oral contraceptives. In women not taking oral contraceptives, the number of correctly-recognized sex stimuli was enhanced during the ovulatory phase, and also during this phase, more stimuli from the other categories were falsely recognized as sex stimuli. Reproductive status may have influenced sensitivity toward sexual information. In a sequel study (Krug et al., 2000), changes in brain electrical activity related to the specific stimuli were examined (i.e., ERPs, event-related potentials). Results indicated a specific effect of the menstrual cycle on the processing of sexual stimuli that increases with deeper emotional processing (a "cognitive" vs. an "affective" task were compared). The valence of the sexual stimuli was heightened during the ovulatory phase. Also, a nonspecific effect was found during the midluteal phase.

In the studies conducted by Krug et al. (1994, 2000), besides sexual stimuli, another stimulus category with reproductive significance was presented: babies. Recognition of baby stimuli was lessened during the midluteal phase (Krug et al., 1994). In the ERP study (Krug et al., 2000), an elevated valence during the midluteal phase was found for all stimuli (including neutral). However, a similar study of Johnston and Wang (1991; Wang & Johnston, 1993) showed a greater emotional valence of stimuli of male models and babies during the midluteal phase, compared with other affective and nonaffective stimuli. They hypothesized that since progesterone, referred to as the "pregnancy" hormone, has behavioral effects of pre-birth fetus caring and after-birth nest-building, an interest in babies and males is an adaptive consequence during the midluteal phase.

In addition to the male-oriented and female-oriented stimuli, we decided to include baby stimuli in our design. Similar to sexual stimuli, baby stimuli may be relevant to individual goals and elicit a strong emotional response. We hypothesized that the affective significance of a baby-stimulus was detected in a first, implicit stage of emotional responding.

EXPERIMENT 2

The purpose of this experiment was threefold: (a) to investigate implicit activation by use of female-oriented sexual slides, (b) to investigate implicit activation by baby stimuli, and (c) to explore stimulus-specific effects of menstrual phase. Women not taking oral contraceptives were tested during three menstrual phases. We asked them to respond to consciously-perceived targets that were preceded by subliminally-presented primes. Primes and targets were pictures with reproductive or neutral content (see Figure 2). The experiment consisted of three series of trials that differed on pictures with reproductive content: male-oriented sexual (Experiment 1), female-oriented sexual, or babies. We predicted a facilitation effect of male-oriented sexual primes on the recognition of male-oriented sexual targets during the ovulatory phase only. We predicted a facilitation effect of female-oriented sexual primes on the recognition of female-oriented sexual targets that would be most prominent during the ovulatory phase. We also predicted a facilitation effect of baby primes on the recognition of baby targets that would be most prominent during the midluteal phase.

In Experiment 1, we kept all variables constant in comparison to the male study (Spiering et al., 2003). For Experiment 2, we made some changes in the design and the apparatus used. We did not determine individual perceptual thresholds since these may vary with the content of pictures as well as with the reproductive status of the participant (cf. Miller, 1991). Subsequently, we improved the design of the recognition test. Weighing theoretical interest against participants' load, we decided to omit the series in which subjective arousal and arousability of slides were the dependent variables. Finally, we modernized stimulus presentations by the use of digital data projectors instead of slide projectors.

Method

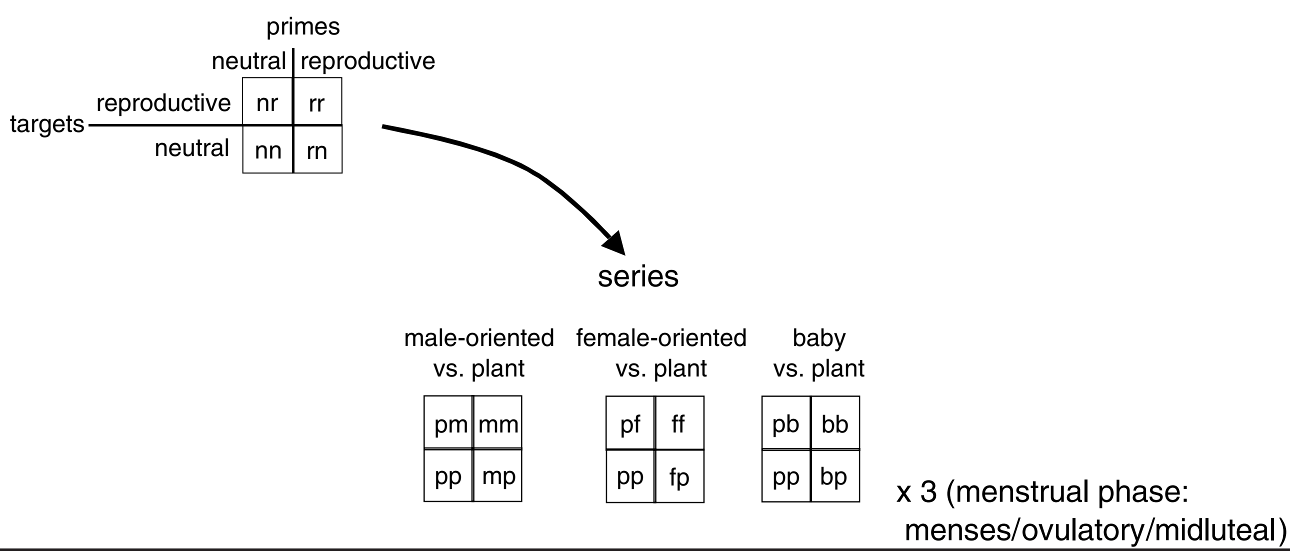
Participants

Heterosexual, spontaneously cycling women were solicited through advertisements posted around a university. They were screened in a standardized interview and considered eligible when they had not been pregnant or lactating during the last 12 months, had not used oral contraceptives during the last 4 months, and reported having regular cycles (cf. Krug et al., 1994, 2000). They were also asked neutral questions (e.g., participation in sports, native language) to obscure the importance of menstrual cycle variables; participants' prior knowledge of the study focus may influence their responses in a manner consistent with any stereotypical beliefs they may hold (Guttridge, 1994). At the end of the interview, they were asked to keep the dates of their first day of menses in a diary. Approximately 3 months later, they were called again. When they still satisfied the conditions for inclusion and when they had the dates of their two last menses, three appointments for the experimental sessions were made.

The menstrual phase for each participant was determined by counting backwards from the first day of the expected next menses (Wang & Johnston, 1993). Ovulation is almost exactly 14 days prior to the onset of the next menses, irrespective of cycle length. During menses, testing was performed on day 2 or 3 of the menstrual cycle. Day 1 was not used to avoid possible confounding effects of physical discomfort (cf. Krug et al., 1994). During the ovulatory and midluteal phases, testing was performed in a three days interval around 14 and 7 days before the expected menstrual onset, respectively. The order of sessions was balanced across participants. For each participant, tests were conducted within the same 3-hour period of the day.

Approximately 1 month after participation, participants were approached again and were asked for their first day of their last menses. These data were used to optimize the initial assignment to the different menstrual phases; the ovulatory phase is brief and difficult to identify accurately from menstrual records alone (Kimura & Hampson, 1994). When, retrospectively determined, ovulation occurred before the three-day interval of testing, this session was reassigned as

Figure 2. Design of Experiment 2: 2 (Prime: reproductive, neutral) X 2 (Target: reproductive, neutral) X 3 (Picture set: male-oriented sexual, female-oriented sexual, baby) X 3 (Menstrual phase: menses, ovulatory, midluteal).



midluteal. When ovulation occurred after the three-day interval of testing, this session was reassigned as menses. When participants were now tested twice in the same menstrual phase, the session that best fitted the phase was used.

Women (N = 91) were initially screened, but only 16 women (M = 21.6 years, SD = 2.1) participated. This final sample contained 34 testing sessions; in Table 4, the number of participants is split up to phase and session. Although we aimed to include 30 women, the data collection had to be stopped because the data projectors were stolen from the laboratory. Because of low power, the experiment should be considered a pilot study. We also made some adjustments regarding our data analyses. To maximize the number of included observations, we did not compare the three menstrual phases in one analysis, but instead compared observations from the ovulatory and midluteal phase with the menses separately. Secondly, the alpha level for statistical tests was set on .10, and effect sizes (partial eta squared) were reported for significant effects.

All participants completed written informed consent prior to participation. They were offered course credits or were paid 14 euro for collaboration. All but one reported being sexually active; all had experienced sexual desire. On a 5-point scale, from *highly dissatisfied* to *highly satisfied*, they reported to be relatively satisfied with their current sexual lives (M = 3.1, SD = 0.7).

Materials

Setting and apparatus differed from Experiment 1 in only three aspects. First, to measure decision times, one button box was placed in front of the participant. This box had seven buttons; only the left and right one were used. Two labels defined the function of these buttons. One label depicted the word *plant*; the other one depicted the words *sex* and *baby* on different sides and participants were requested to turn around this label to match the different experimental tasks. The position (left/right) of the labels was randomized across participants but was held constant between the different sessions. Second, three digital data projectors, each outfitted with a Displaytech ferroelectric liquid crystal shutter, were used to project the images on the screen. Each data projector as well as all three shutters was controlled by the application "Beam" (in-house software). Third, the size of the projected images was 22 cm x 28 cm. Viewing distance was approximately 130 cm, resulting in a 10° horizontal and 12° vertical visual angle.

Other than the mask, four kinds of pictures were presented: *male-oriented sexual, plant, female-oriented sexual*, and *baby*. Pictures of the *male-oriented sexual* and *plant* set were digitized from slides of Experiment 1, the sexually explicit and plant slides, respectively. The *female-oriented sexual* pictures depicted heterosexual couples making love. Characteristics of these slides were focus on female's enjoyment, a general positive atmosphere, attention to a nice background (e.g., nature, fireplaces) and genitals not explicitly in focus (cf. Geer & McGlone, 1990; Heiman, 1977). Selection was based on subjective assessments of two female students. We attempted to establish maximum interrater reliability. The pool of slides from which the selection was made originated from our previous study (*romantic* slides, Spiering et al., 2004). In this study, it turned out that the romantic primes yielded the highest addition of subjective ratings to sexual targets in women, compared to sexually explicit primes. Pictures of the *baby* set depicted clothed babies playing, laughing, sitting, or crawling.

Table 4. Number of Participants per Phase per Session

	1st session	2nd session	3rd session	total
Phase				
menses	4	8	2	14
ovulatory	3	2	2	7
midluteal	9	2	2	13
total	16	12	6	34

All pictures were carefully selected to match on stimulus dimensions as complexity, contrast, and luminance. This selection was based on objective criteria. For example, the number of main elements of a picture may not exceed two, very dark or light pictures were adjusted by computer, and we tried to accomplish a broad range of colors for all sets. However, final decisions were based on subjective assessments.

Three stimulus series contained 40 trials each. In each trial, a consciously perceived *reproductive* (i.e., baby or sex) or neutral (i.e., plant) target was preceded by a subliminally-presented congruent or incongruent prime (see Figure 2). Decision time was the dependent variable. Participants were asked to categorize the targets as quickly as possible by pushing either the sex/baby or plant button. Decision time was measured from onset of the target to the pressing of a button. Experimental trials proceeded as in Experiment 1, but prime exposure duration was set at 10 ms for all participants and there was no delay between the participant's response and the start of the next trial (vs. 1,000 ms in Experiment 1).

The experimental design of the study was a 2 (Prime: reproductive, neutral) X 2 (Target: reproductive, neutral) X 3 (Picture set: male-oriented sexual, female-oriented sexual, baby) X 3 (Menstrual phase: menses, ovulation, midluteal) within-subjects factorial. The use of digital data projectors permitted a fuller randomization compared to Experiment 1. Within each series, the sequence of the conditions was randomized afresh for each session. Regarding randomization of pictures (i.e., the specific pictures that fill in the conditions), we first randomly split the collection of plant pictures in three, with 40 for each series. We made three different versions per series that were composed of different prime-target combinations. These versions were randomly distributed among the sessions. The sequence of the series was randomized again for each session.

After the experimental series, a forced-choice recognition test was presented. The design of this test differed from earlier studies (Janssen et al., 2000; Spiering et al., 2003). To maximally equalize trials in the recognition test with trials in the experimental series, we presented pictures subliminally (in stead of supraliminally; Merikle, Smilek, & Eastwood, 2001). The sequence of events for a trial in the recognition test differed in one aspect from an experimental trial: the presentation of the target was now replaced by a second presentation of the mask (cf. the threshold determination procedure of Experiment 1). Participants were requested to guess whether a reproductive or a neutral picture was presented between the double presentations of the mask. In one test, 15 new sex pictures were mixed with 15 new plant pictures. In a second test, 15 new baby pictures were mixed with 15 new plant pictures. Participants could respond by pushing either the sex/baby or the plant button.

To assess whether mood at time of testing was a confounding variable, we administered a Dutch-adapted version of the Profile of Mood Scale (POMS; McNair, Lorr, & Droppleman, 1971; Van Ark, Marburger, Mellenbergh, Vorst, & Wald, 1995). Participants responded to 91 adjectives on a 5-point scale ranging from 0 (*not at all)* to 4 (*extremely)*. This instrument yields scores for nine constructs: angry, content, courting, depressed, elegant, fatigued, tense, unmoved, and vigorous. For women, internal consistencies (Cronbach's alpha) of the subscales ranged between a = .68 and a = .93. In addition, participants were asked two questions. The first one asked participants to indicate how sexually aroused they felt (Question 1 of Experiment 1: "To what degree did you feel sexually aroused at this moment?"). The second question was a more indirect and evaluative assessment of sexual arousal (an adapted version of Question 2 of Experiment 1: "To what degree did you find the sexual pictures sexually arousing?"). The questions could be answered on a 7-point scale (cf. Experiment 1).

Procedure

A female experimenter tested all participants individually. The experiment consisted of three sessions of two stages: categorization tasks and forced-choice recognition tests. At the start of the first session, the participants answered questions in writing about biographic variables, sexual experience, and sexual problems. Before each session, participants were asked to complete the POMS; at the end of each session, we administered the two questions regarding subjective arousal and arousablity of pictures, and we conducted an exit interview. At the end of the third session, we provided participants with information about the theoretical background of the study.

Stage 1: Categorization tasks. There were two differences compared to Series 1 of Experiment 1. First, there were three categorization tasks in each session: two sex versus plant and one baby versus plant. Second, before each series of 40 trials, there were eight practice trials.

Stage 2: Forced-choice recognition tests. There were two recognition tests: one sex versus plant and one baby versus plant. Participants were told that there was a picture between double presentations of the mask that they probably could not see. They were told that this picture was a sex (or baby) or plant picture and were requested to guess its content by pushing either the sex (or baby) or plant button. Before each series of 30 trials, there were eight practice trials.

Results

Recognition Tests

We determined accuracy of the reproductive-neutral (i.e., either baby-plant or sex-plant) decisions obtained during the recognition tasks by calculating hit rates (see Table 5). For each menstrual phase, hit rates for baby and sex stimuli were about .50, suggesting that participants were guessing the true nature of the presented stimuli. Additionally, hit rates did not increase over sessions, indicating no sequence effect.

Decision Times

Thirty-four sessions of 40 trials led to an initial pool of 1,360 trials. The outlier procedure (see Experiment 1) led to the exclusion of 140 (10.3%) decision times. Wilcoxon tests were conducted to evaluate whether the mean number of outliers differed between sessions or menstrual phases. None of these comparisons were significant: Session 1 versus Session 2, $z = 0.36$, $p = .72$; Session 2 versus Session 3, $z = 0.63$, $p = .53$; ovulatory phase versus menses, $z = 0.21$, $p = .83$; midluteal phase versus menses, $z = 0.06$, $p = .95$.

Ovulatory phase. Regarding the male-oriented sexual pictures, a 2 (Prime: sex, plant) X 2 (Target: sex, plant) X 2 (Phase: ovulatory, menses) repeated-measures ANOVA with decision time as the dependent variable (Table 6) revealed a significant interaction of Prime X Target, $F(1, 6) = 4.12$, $p = .09$. Follow-up tests showed no difference regarding neutral targets, $F(1, 6) = 1.82$, $p = .23$, $h^2 = .23$;

Table 5. Accuracy of Decisions in Recognition Tasks per Menstrual Phase and per Session (*N* = 16)

	Baby stimuli		Sexual stimuli	
	Hit rate		Hit rate	
	M	*SD*	*M*	*SD*
Menses	0.53	(0.15)	0.50	(0.19)
Ovulatory	0.56	(0.14)	0.48	(0.15)
Midluteal	0.55	(0.13)	0.49	(0.10)
1st session	0.55	(0.14)	0.50	(0.16)
2nd session	0.53	(0.14)	0.50	(0.11)
3rd session	0.53	(0.14)	0.44	(0.19)

Table 6. Mean Decision Time (in ms; *SD* in parentheses) in three Categorization Tasks for Reproductive and Neutral Targets by Menstrual Phase and Prime Content in Experiment 2 (*N* = 16)

	Menses						Ovulatory						Midluteal					
	Male-oriented Sexual		Female-oriented Sexual		Baby		Male-oriented Sexual		Female-oriented Sexual		Baby		Male-oriented Sexual		Female-oriented Sexual		Baby	
Reproductive targets																		
Reproductive primes	431	(82)	466	(101)	456	(84)	451	(56)	516	(104)	471	(83)	469	(118)	505	(83)	475	(91)
Neutral primes	436	(90)	471	(89)	449	(78)	475	(78)	501	(88)	488	(95)	494	(124)	503	(96)	464	(83)
Neutral targets																		
Reproductive primes	465	(72)	483	(70)	468	(67)	490	(89)	523	(88)	527	(93)	467	(54)	510	(63)	519	(83)
Neutral primes	437	(55)	466	(72)	454	(72)	490	(66)	500	(71)	508	(91)	491	(70)	497	(62)	502	(77)

however, a facilitation effect of sexual primes, compared to neutral primes, regarding recognition of sexual targets approached significance, $F(1, 6) = 3.60$, $p = .11$, $h^2 = .38$. No other main or interaction effects were found. Regarding the female-oriented sexual pictures, a similar 2 (Prime) X 2 (Target) X 2 (Phase) ANOVA revealed no significant main or interaction effects.

Regarding the baby pictures, a 2 (Prime: baby, plant) X 2 (Target: baby, plant) X 2 (Phase: ovulatory, menses) repeated-measures ANOVA with decision time as the dependent variable revealed a main effect of Phase only, $F(1, 6) = 7.05$, $p = .04$, $h^2 = .54$. Participants' responses were slower during the ovulatory phase compared to menses. No other main or interaction effects were found.

Midluteal phase. Regarding the male-oriented sexual pictures, a 2 (Prime: sex, plant) X 2 (Target: sex, plant) X 2 (Phase: midluteal, menses) repeated-measures ANOVA with decision time as the dependent variable revealed a significant interaction of Prime X Target, $F(1, 10) = 7.83$, $p = .02$. Follow-up tests showed no difference regarding neutral targets, $F(1, 10) = 2.16$, $p = .17$, $h^2 = .18$; however, a facilitation effect of sexual primes, compared to neutral primes, regarding recognition of sexual targets was significant, $F(1, 10) = 10.33$, $p < .01$, $h^2 = .51$. Also, a significant interaction of Prime X Phase was found, $F(1, 10) = 16.17$, $p < .01$. Follow-up tests showed that participants' responses during menses were slower after sexual primes as compared to neutral primes, $F(1, 10) = 3.29$, $p = .10$, $h^2 = .25$, and were faster after sexual primes during the midluteal phase, $F(1, 10) = 19.46$, $p < .01$, $h^2 = .66$. No other main or interaction effects were found. Regarding the female-oriented sexual pictures, a similar 2 (Prime) X 2 (Target) X 2 (Phase) ANOVA revealed no significant main or interaction effects.

Regarding the baby pictures, a 2 (Prime: baby, plant) X 2 (Target: baby, plant) X 2 (Phase: midluteal, menses) repeated-measures ANOVA with decision time as the dependent variable revealed a main effect of Target, $F(1, 10) = 10.40$, $p = .01$, $h^2 = .51$, together with a significant interaction of Target X Phase, $F(1, 10) = 4.24$, $p = .07$. Follow-up tests showed no differences during menses, $F(1, 10) = 0.24$, $p = .64$, $h^2 = .02$; however, participants' decisions for baby targets, compared to neutral targets, were faster during the midluteal phase, $F(1, 10) = 21.32$, $p < .01$, $h^2 = .68$. No other main or interaction effects were found.

Mood

We calculated the mean scores on the subscales of the adapted version of the POMS and the mean scores of the questions regarding sexual arousal and arousability of pictures (Table 7). There were no large or systematic changes between the different menstrual phases, which indicates no confounding factor of mood.

Discussion

Before discussing the results of this experiment, we must

Table 7. Mean Scores of Mood (POMS), Subjective Arousal (Question 1), and Arousability of Pictures (Question 2) per Menstrual Phase (*N* = 16)

	adapted POMS (0 - 4)																		Question 1 and 2 (1- 7)			
	Angry		Content		Courting		Depressed		Elegant		Fatigued		Tense		Unmoved		Vigorous		Sexual Arousal		Arousability of Pictures	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Menses	0.2	(0.3)	2.5	(0.8)	1.1	(1.0)	0.0	(0.1)	1.2	(0.8)	0.8	(0.7)	1.8	(0.5)	0.5	(0.4)	2.2	(0.8)	2.1	(1.2)	3.0	(1.6)
Ovulatory	0.8	(0.6)	1.7	(0.8)	0.9	(0.6)	0.4	(0.4)	1.6	(1.1)	1.1	(0.6)	1.9	(0.5)	0.7	(0.7)	1.7	(1.0)	1.9	(0.4)	2.7	(0.8)
Midluteal	0.4	(0.5)	2.0	(0.9)	0.8	(0.9)	0.2	(0.5)	1.2	(0.7)	1.0	(1.0)	1.9	(0.4)	0.7	(0.7)	1.9	(0.7)	1.9	(0.8)	2.7	(1.4)

report an important limitation. The number of women that participated was far fewer than the number we intended to achieve. Especially regarding effects of menstrual phase, the results should be considered as preliminary. We limited the number of analyses and also accepted a probability of .10 (in stead of .05) of Type I errors. This said, we interpret the data following the three hypotheses under study: implicit activation by female-oriented sexual slides, implicit activation by baby stimuli, and stimulus-specific effects of menstrual phase.

Contrary to prediction, the female-oriented sexual primes did not facilitate recognition of sexual targets. In a conscious version of this priming task (Spiering et al., 2004), these female-oriented sexual pictures generated stronger subjective sexual arousal in women compared to male-oriented sexual pictures. This effect can be attributed to differences in explicit memory, which, reasoning from the results of this experiment, do not extrapolate to implicit memory. On the contrary, the male-oriented sexual primes did facilitate recognitions of sexual targets. This indicates that implicit activation of the sexual system in women is possible. Like men (Janssen et al., 2000; Spiering et al., 2003), women may nonconsciously recognize a stimulus as sexual.

There were no effects of subliminally-presented baby stimuli. The set of stimuli that is competent to activate emotional responding nonconsciously is limited. Besides sexual features, empirical evidence for implicit activation was found after fear stimuli (e.g., spiders and snakes; Öhman & Soares, 1994) and angry and happy faces (Morris, Öhman, & Dolan, 1998; Whalen et al., 1998). Baby pictures may not add to this set. On the other hand, our sample may not be optimal; baby stimuli may not be highly relevant to individual goals of the young students we tested.

There were some interesting cycle effects, especially with respect to the midluteal phase. During this phase, participants' decisions for baby targets were faster compared to neutral targets. Regarding the male-oriented sexual stimuli, decisions after sexual primes were faster during the midluteal phase compared to neutral primes. There were no such effects during menses or ovulation. Like in the study of Johnston and Wang (1991; Wang & Johnston, 1993), an elevated level of progesterone seems to be accompanied by a higher sensitivity for visual reproductive stimuli.

Results of the recognition tests showed that participants were unaware of the content of the subliminal picture presentations. We did not perform separate tests for male-oriented versus female-oriented sexual pictures. In view of the different effects of these pictures, in retrospect this is unfortunate. In the discussion of Experiment 1, we suggested that perceptual thresholds for the male-oriented explicit sexual slides might differ between men and women. Similarly, it would be interesting to see whether perceptual thresholds in women differ between the different kinds of sexual slides. There were no confounding influences of mood. Overall, the data presented provide preliminary support for implicit sexual activation in women.

Conclusion

In men, subliminally presented sexual primes facilitated recognition of sexual targets (Janssen et al., 2000; Spiering et al., 2003). Without the need of conscious evaluation, sexually competent stimuli activate sexual implicit memory and set up sexual responding. The two experiments reported here were conducted with the objective to replicate this result in a sample of women. Taken together, the two experiments do not give the unequivocal picture we hoped for. At the outset, we hypothesized that implicit processing of sexual information is similar for both genders and that gender differences merely exist in explicit sexual memory. A direct replication failed, however (Experiment 1). Subsequently, we hypothesized that women might already appraise sexual stimuli differently in an initial, implicit stage of responding. We added a female-oriented sexual picture set that on a conscious level was appraised as more arousing compared to the male-oriented sexual pictures (Spiering et al., 2004). We predicted (Experiment 2) that these pictures might nonconsciously activate implicit sexual memory. Results were contrary to this prediction: no effects were found with female-oriented sexual pictures, whereas male-oriented sexual pictures did produce a priming effect.

All in all, a preliminary conclusion could echo the initial hypotheses: implicit processing of sexual information may be similar for both genders. Like men, women might nonconsciously recognize a sexual stimulus as "sexual." This recognition process seems unrelated to the potential of the stimulus to elicit subjective arousal, because female-oriented sexual slides produced no effects, and recognition could depend on the presence of simple archetypical features such as genitals or breasts, because these features were more present in the male-oriented sexual pictures. That a direct replication failed could be attributed to the fact that results of the recognition test differed from the male study (Spiering et al., 2003). The derived SOAs in Experiment 1 could have been insufficiently strong to produce any effects.

It is possible that although implicit information-processing is qualitatively similar for women and men, there is a quantitative difference. Men do seem to be more strongly motivated sexually than women; they masturbate more frequently (Oliver & Hyde, 1993), they report fewer problems concerning low sexual desire (Simons & Carey, 2001), and problems of hypersexuality mostly concern men (Kafka, 2001). Men, as compared to women, have been found to be more easily aroused by visual stimuli (Geer et al., 1993). The effect size of priming, which is already small in the male study, might be even smaller for women.

In Experiment 2, effects of the menstrual cycle were taken into account. Sensitivity for sexual and baby stimuli may change with estrogen and progesterone levels, respectively (cf. Johnston & Wang, 1991; Krug et al., 1994, 2000; Wang & Johnston, 1993). Results showed that stimulus-specific effects occurred only during the midluteal phase, when progesterone is at maximum. Experiment 2 suffers from low power and should be considered as a pilot study awaiting replication. However, it is of interest to include these hormonal effects in the design of future studies. We recommend taking endocrine measures at the time of testing, when possible, to be more certain of the hormonal status of the participants. Overall, our data provide preliminary support for the role of implicit processes in the female sexual system.

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