OLFACTORY SENSITIVITY AND THE MENSTRUAL CYCLE

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During the last few years the interest in the relationship between olfaction and sexuality was raised considerably as a result of the findings of people like Van der Lee and Boot, Whitten, Bruce and Parkes. In their experiments, on the influence of odors on the menstrual cycle in mice, it was shown that the presence of the odor of the male influenced the timecourse of the menstrual cycle as well as the development of pregnancy. Parkes and Bruce (1) gave a good review of the results of these experiments in their article on "Olfactory stimuli in mammalian reproduction". They also developed a theory, called exocrinology, in which they regarded the male odor as a chemical messenger which influenced the secretion of the normal endocrine hormones. Along these lines we should also mention the work of Kloek (2), who showed that the human nose is sensitive to the odor of several steroid sex-hormones and who also proved that these steroid hormones are secreted directly through the human skin in a quantity sufficient to be detected by a police dog.

The experiments mentioned so far were all concerned with the influence of odors on the course of the menstrual cycle. It is also possible to do the reverse and to investigate the influence of the menstrual cycle on the olfactory sensitivity to certain odors.

Le Magnen (3) was the first to demonstrate that there existed, at least for

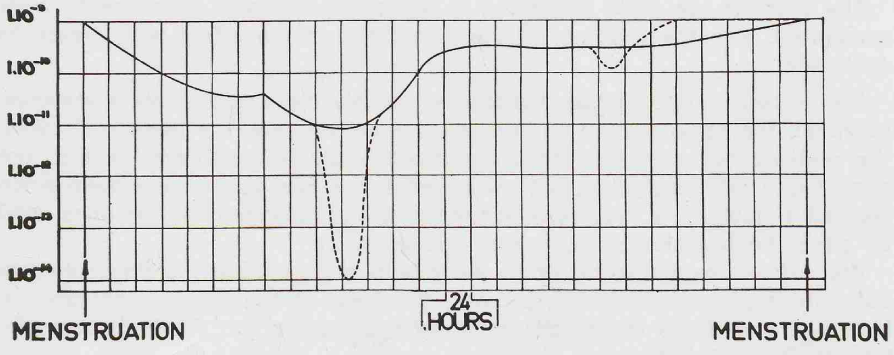

Fig. 1. J. Le Magnen — Average fluctuations of the sensitivity to exaltolide along with the menstrual cycle. Dotted lines: exceptional cases.

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one odor, the so-called exaltolide, a relationship between the olfactory sensitivity in women and the course of their menstrual cycle. His results are illustrated in figure 1.

During menstruation the threshold is at its highest (i.e. sensitivity is at its lowest). Shortly afterwards the threshold goes down to a minimum situated in time around or just before ovulation. Then there is a rather sharp rise in threshold to a level just under the one found at menstruation. This level is maintained until the onset of menstruation.

The dotted lines represent exceptional cases. One of these is a case in which a prolonged menstrual cycle is accompanied by a raise in threshold some days before menstruation.

According to Le Magnen the general phenomenon is specific with regard to exaltolide. He used several other substances, but the curves obtained for these substances show remarkably little variation over the same period. This should not surprise us too much since exaltolide has a musky odor and musk is considered to be a sexual attractant in some male mammals.

Two americans, Schneider and Wolf (4), however, using citral as a stimulus, found a raise in threshold during menstruation. Nevertheless, we should remember that the intriguing thing in Le Magnen's data is not the relatively small drop in sensitivity during menstruation, but the marked raise in sensitivity around ovulation. Since Schneider and Wolf did not find such a raise in sensitivity, Le Magnen's claim of the specificity of the effect could be maintained.

Kloek, in a footnote to his earlier mentioned article, denies to have found any confirmation of Le Magnens' results in an extensive experiment with exaltolide. Unfortunately, the apparatus used by him for measuring thresholds was rather inadequate.

Finally, we should mention here a very recent study by Cluzel (5), who showed that such changes in the normal genital activity as provoked by castration in women and menopause, result in a loss of olfactory sensitivity to exaltolide. On the basis of these and other findings Cluzel emphasizes once more the relationship between olfaction and the endocrine system.

The problem we were interested in as far as our own experiments were concerned, was the problem of the specificity of the effect with regard to exaltolide.

We hoped, using another substance, namely meta-xylene, as a stimulus, to obtain the same sort of variations in sensitivity with the menstrual cycle. We realised however, that these variations would be much smaller than the ones found with exaltolide, but we hoped to be able to measure them since we had a much more precise olfactometer at our disposal than the ones used by either Le Magnen or Schneider and Wolf.

We did two experiments, which were both performed at the Psychological Laboratory of Utrecht University with the help of the Central Institute for Nutrition and Food Research of the Organisation for Applied Scientific Research in the Netherlands T.N.O.

The olfactometer used was a duplicate of the olfactometer built by Stuiver (6) at Groningen University. The only change in the apparatus was the omission of the injection apparatus, which we replaced by a very simple device for regulating the speed of inhalation of the subject. This change provided the

subject with the possibility of natural inhalation, a procedure to be preferred above any injection technique.

In the first experiment only two subjects took part, one female, age 22, and one male, age 26, as a control. We had to limit ourselves in the number of subjects since precise thresholdmeasurement in olfaction is very time-consuming as a result of the long recovery periods after adaptation. Both subjects worked five days a week for the full day. The whole experiment lasted 26 days. Unfortunately the experiment had to be stopped after that period because the female subject caught a cold. This prevented us from showing an overlapping period between two cycles, but since the two cycles during which we measured had a length of 27 and 28 days respectively, we can at least show the results of approximately one cycle. Both subjects were tested each day with five series of about 45 minutes duration. Between series there was a 45 minutes resting period. Each series consisted of 30 stimuli, which were equally divided over five different concentrations and presented in random order. One of the five concentrations was a control or zero concentration. Between stimuli there was a one minute resting period to make sure that the subject had at least to a large extent recovered from adaptation.

From the results of these tests a 50% threshold was calculated for each day. These daily thresholds were then grouped for each of the subjects according

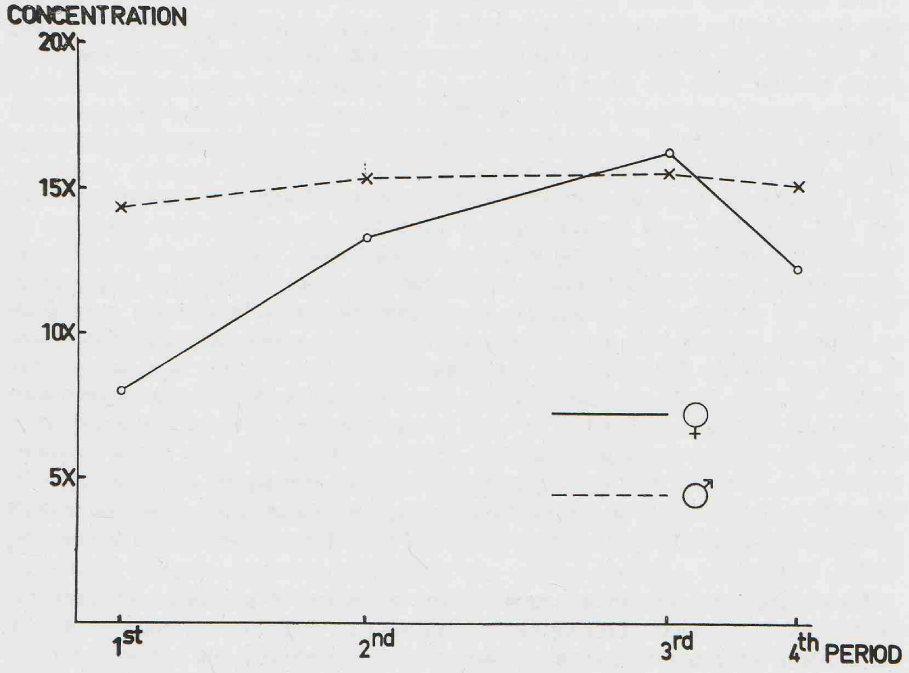

Fig. 2. Averages of the daily thresholds, grouped according to the periods of the menstrual cycle of the female subject. X of concentration is about 1.10^{-8} mol/liter.

to the different periods of the menstrual cycle of the female subject. The results of these groupings are illustrated in figure 2.

The first period consisted of three days at the end of which ovulation took place according to the subject, who claimed she was usually aware of its presence. The point shown for the first period indicates the mean of the three daily thresholds. The second period contained 14 days from ovulation to the onset of menstruation. Thresholds went steadily up throughout this period. The third period was the actual period during which the subject menstruated and lasted 7 days. Towards the end of this period the thresholds were already declining. The fourth and last period consisted of two days only, due to the illness of the subject. Nevertheless the results show a marked drop in threshold. Five days after the end of this period ovulation took place, if we should once more believe the subject. As said before, the total duration of this second cycle was 28 days.

According to the Fischer t-test for differences between means the differences between periods 1 and 2 between 1 and 3 were significant at the 1% level. The difference between periods 3 and 4 was significant at the 5% level, whereas the difference between periods 2 and 3 was not significant. None of the differences found for the male subject over the same periods were significant.

The curve thus found for meta-xylene has the same general shape as the one found by Le Magnen for exaltolide, the only important difference being the fact that the variations in olfactory sensitivity found in our experiment are much smaller than the ones found by Le Magnen.

From these results we concluded that the menstrual cycle influenced the olfactory sensitivity to metaxylene In the same way as the sensitivity to exaltolide, if to a much lesser degree.

Of course we realised that the main handicap of our first experiment was the fact that only one female subject took part in it. Therefore we tried to confirm our findings by using a group of 20 female subjects in the second experiment. These subjects came in only twice a week and for half a day only. The results of this experiment are of course less reliable and are even less so because we lost half of our crew during the five week period as the result of a flu epidemic. Nevertheless the results, tentative as they are, seem interesting enough to be mentioned here. Our procedure in this experiment was somewhat different. Instead of five we used only two different concentrations here. One of them was a control or zero concentration. The other concentration was at about average 50% threshold level. The series constructed with these two concentrations consisted of 5 zero stimuli and 20 ordinary stimuli presented in random order. Per half day three of these series were presented to the subject.

We then used a chi-square test for the divisions of positive and negative responses to both concentrations as an index of the discrimination ability of the subject. This whole procedure has certainly disadvantages but we adopted it because it seemed less time-consuming and therefore permitted us to include more subjects. The average results of the whole group of 10 subjects are shown in figure 3.

At the point marked M we plotted the results of the first half day after the

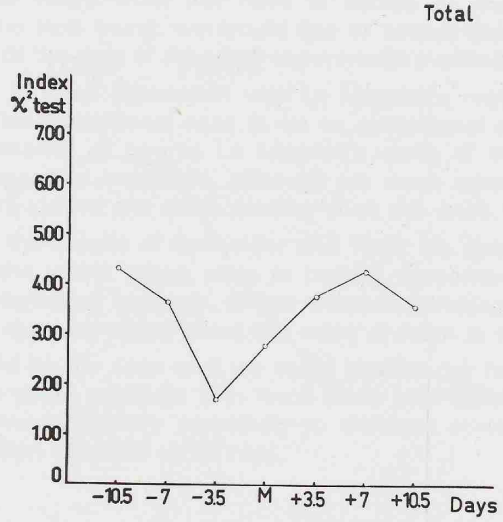

Fig. 3. Average sensitivity of 10 subjects at different periods before and after menstruation (M).

onset of menstruation. As a result of this the actual beginning of menstruation was a bit earlier than indicated by this point. The numbers shown indicate the number of days before and after this point M.

The results were rather disappointing, for it was clear that discrimination ability or sensitivity was at its lowest just before the onset of menstruaton, but sensitivity seemed equally high both before and after that specific period. In this way the results did confirm the findings of Schneider and Wolf about loss of sensitivity at menstruation, but at the same time they contradicted the results of our own first experiment. There was no specific raise in sensitivity towards the period of ovulation. Then we remembered, in the midst of our deception, the earlier mentioned exceptional case of Le Magnen in which a prolonged cycle was accompanied by a raise in sensitivity before menstruation. We divided our group into two groups according to length of the menstrual cycle. Both groups consisted of five subjects. In the group with the short cycli the duraton of the cycles was 21, 24, 24, 25 and 25 days respectively, whereas in the other group the duration of the cycles was 28, 28, 33, 35 and 36 days. Figure 4 shows the result of this division.

As these results indicate, the group with the short cycli behaved exactly as we would have expected from our first experiment, (i.e. specific raise in sensitivity towards ovulation) whereas the group with the long cycli shows precisely the opposite effect. Here we find high sensitivity some days before menstruation and no raise in sensitivity towards ovulation.

Unfortunately, the groups were too small to use any statistics effectively. In general, the curves of the individual subjects in each group were in agreement with the trend shown by the group as a whole. Only one of the two girls with a 28 day cycle formed an exception. Her curve resembled the one obtained for the whole group (fig. 3).

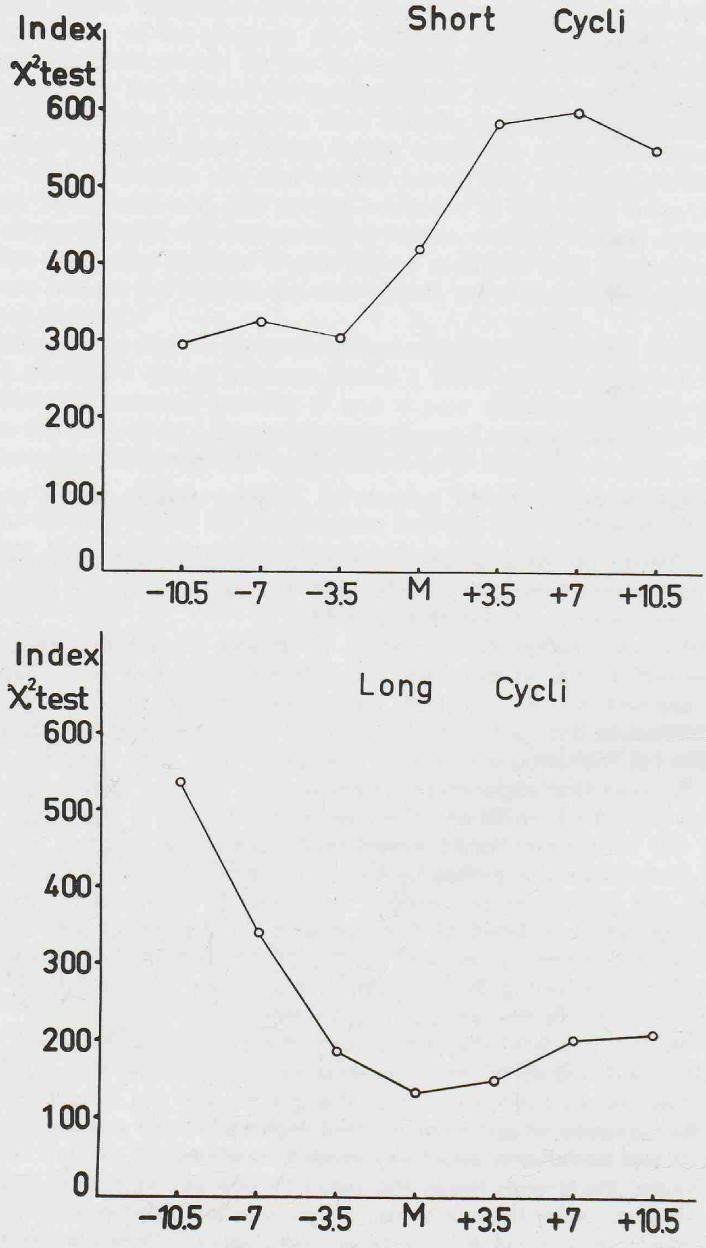

Fig. 4. Average sensitivity curves for groupes according to duration of the menstrual cycle.

Nevertheless future work will have to decide on the reliability of these results. For the time being, we would like to accept them tentatively and to see how they fit the data of the other experiments mentioned.

They seem in good agreement with Le Magnen's results, provided we do not consider his exceptional case to be as exceptional as he states. For the rest they contradict of course Le Magnen's claim of the specificity of the effect with regard to exaltolide, although we must admit that the variations found for meta-xylene are much smaller than the ones found for exaltolide.

As regards the results of Schneider and Wolf, we already pointed out that our data for the whole group were in perfect agreement with them (fig. 3). It would be interesting however, to see whether grouping of their data according to cycle duration would show the same division in two opposite effects.

If this should be the case or if we could confirm our results in more extensive work, we could conclude with much more confidence that the endocrine system influences olfactory sensitivity to different stimuli in an even more intricate way than assumed up till now.

SENSIBILITÉ OLFACTIVE ET LE CYCLE MENSTRUEL

Après avoir examiné la literature sur les phénomènes olfacto-sexuels en générale et les variations de la sensibilité olfactive en fonction du cycle menstruel en particulier, nous publions les résultats de deux travaux expérimentaux. Tous les deux ont été effectués avec un olfactomètre du type Stuiver et le metaxylène comme stimulus odorant.

Dans le premier nous avons mesuré chaque jour les seuils olfactifs chez deux sujets, une femme et un homme. Chez la femme nous avons constaté une variation de la sensibilité olfactive en fonction du cycle menstruel semblable à celle trouvé par Le Magnen pour l'exaltolide, c'est à dire un abaissement de la sensibilité pendant la menstruation et une sensibilité très élevée juste avant ou à l'ovulation. Chez l'homme nous n'avons pas constaté de variation du seuil (fig. 2).

Dans une deuxième protocole expérimentale nous avons mesuré deux fois par semaine les seuils olfactifs de 20 sujets féminins. Malheureusement les résultats de 10 sujets ne sont avérés inutilisables par suite d'une épidémie de rhume. Chez les 10 autres sujets nous avons bien trouvé l'abaissement de la sensibilité pendant la menstruation, mais nous n'avons pas constaté cette fois une exaltation spécifique de la sensibilité après la menstruation (fig. 3).

Néanmoins après avoir divisé les sujets en deux groupes suivant la durée de leur cycle menstruel, il apparait que la groupe à cycles courts (26 jours et moins) manifeste l'effet prévu alors que la groupe à cycles longs (27 jours et plus) manifeste au contraire une sensibilité élevée avant mais pas après la menstruation (fig. 4).

La variation de la sensibilité olfactive en fonction du cycle menstruel semble être dépendante de la durée du cycle.

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