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A COMPARISON OF THE SEXUAL AND CATNIP RESPONSES OF DOMESTICATED CATS

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Catnip has long been known to hold some unidentified power over all members of the cat family—from lions to the domesticated household cat. As long as their professions have existed, photographers and hunters have relied on the powers of catnip to aid in photographing and capturing the larger wild cats. And, at the same time, domestic cat owners have used catnip to give new life to old cats or to make younger cats seem drunk.

Catnip grows wild throughout much of the Western World as Gary F. Palen asserts, "Catnip (*Nepeta Cataria*) or catmint, is a member of the mint family and grows wild over a large area of America and Europe."¹

After the photographers and hunters, the first people to take an interest in catnip were the chemists. The chemists tried to break down the aromatic components of catnip to show that the smell and not the taste of catnip causes the well known response. It was Neil B. Todd who was the first to prove this hypothesis.

However, the first chemist to break catnip down into its components was S. M. McElvain. Dr. McElvain was able to show that the lactone nepetalactone was the single active chemical component of Oil of Catnip. McElvain showed nepetalactone to be an enol lactone which he was able to break down even further into its acids, bases, and C-Methyl groups. McElvain also tried to theorize as to what the structure of nepetalactone was, but he never singled out one definite structure.² Jerrold Meinwald did.

As he states himself, Meinwald was able to narrow the number of possible structures down to ten, "Neglecting stereochemical considerations, and assuming the validity of the cyclopentane postulate, it can be readily seen that there are ten discrete structures possible for nepetalactone . . ."³ Then the purpose of his work was to choose the one correct structure of nepetalactone from his ten possibilities. By close examination and a careful elimination process Meinwald was able to scratch nine structures from his list to arrive finally at the correct structure of nepetalactone: And Meinwald was able to state that this was the correct structure mainly "for the reason that it alone comprises two isoprene units joined "head-to-tail."⁴

In order to relate the catnip response and the sexual response of cats "head-to-tail" the sexual behavior of cats must first be examined in detail for comparison later to the catnip response. The sexual response of both the male stud cat and the female depends entirely on the estrous cycle of the female. When the female is in "heat" then and only then will the male cat respond and follow his normal sexual pattern.

The female cat comes in "heat" or "estrus" several times a year and at that time mating or some comparable stimulus causes the eggs to be released spontaneously from the ovaries. The estrus female cat is easily identified by the peculiar mating position she assumes. This position is best described by Richard E. Whalen: "... forelegs collapsed, head lowered back curved in lordosis, perineal area raised."⁵

When an active, experienced male cat is exposed to an estrus female, he will utter a specialized "sex call" which isn't heard at other times. The male then takes the loose skin of the female's neck in his teeth (neck grip) and the female takes the mating position. The neck grip tends to make the female immobile so the male can mount her.

"The female bends her back in a position of lordosis, with her forelimbs flexed and her forearms lying flat on the floor. Thus her thorax is lowered, while her pelvis is raised.

"At this time the female begins to **tread** by pushing against the floor with her hind legs, and with her tail bent sharply to one side," asserts Dr. Rosenblatt.⁶ Thus the male's thrusts toward the female are unhindered by the female's tail and insertion or **intromission** can be achieved. The time lapse from mount to intromission is known as the **intromission delay**.

After mating the female turns quickly and violently on the male, hisses at him, claws at him, and throws him from her back. The **after-reaction** ensues and of this Dr. Rosenblatt states, "The female then begins licking her paws and perineal region, and these actions are followed by extremely vigorous rolling on the floor or rubbing against the walls of the room. Meanwhile the male also licks himself. Then after a variable lapse of time the pair will repeat the entire pattern and the sexually experienced pair can make from four to thirteen successful repetitions in a half hour.

Such is the description of the sexual behavior of the sexually experienced male and female. But for the purposes of this paper, it will be well to look at the sexual behavior of naive males and females and the behavior of spayed females and castrated males.

Many people believe that the sexually inexperienced cat will show normal patterns of sexual behavior the first time it is introduced to sex and required to yield a sexual response. Richard Whalen backs this by asserting, "Animal sexual behavior is often thought of as unlearned, genetically organized at birth, and unresponsive to environmental pressures during development and at adulthood."⁸ However, Dr. Whalen disagrees with this hypothesis as he argues, "In spite of this stereotyped belief, adult sexual experience does seem to influence mating performance in certain experiences."⁹ For example,

the sexually experienced castrated male cat shows a more complete sexual pattern than does the sexually inexperienced castrated male, but this will be discussed more fully a little later in the paper.

Dr. Whalen set out to disprove the hypothesis that the sexual behavior of cats was natural and unlearned the first time a sexual response was required of a cat. He realized that naive female cats—even when given exogenous oestrogen to help create “heat”—would not mate readily in the laboratory. The naive females would always take the mating position by themselves or when induced to by perineal tapping by the investigator. However, when an experienced male was placed in the cage with the naive female, the female would hiss at the male and then back in to a corner of the cage to make herself invulnerable. Every attempt made by the male to take even a neck grip was without success. The naive female resisted every effort made by the male on any day that they were put together.

However, if the investigator held the naive female so the male could mount her and achieve intromission, the female’s resistance was broken and she would thereafter accept the male without a fight and without intervention by the investigator. With each successive test, the female allowed more intromissions in less time. And eventually the female would even accept a strange male. So Dr. Whalen concludes, “Thus it would seem that the final stereotyped performance of the mating pattern of the adult female cat is learned. Hormones induce the appropriate postural responses, yet mating experience seems necessary to condition behavioral receptivity . . . The display of adult mating behavior is therefore interpreted as a combined function of hormonal state and learning reinforced by the intromission response.”¹⁰

Similarly naive male cats must learn the proper sexual responses for these responses do not come naturally at the first opportunity for sex. A naive male cat rarely achieves an intromission on his first attempt. Usually each step of the normal sexual pattern is learned in sequence—one at a time from neck grip to intromission.

Dr. Rosenblatt and Dr. Aronson discovered that male cats with maximum sexual experience were superior in sexual behavior to the males with minimum sexual experience after castration, “. . . when this superiority was measured by (1) presence or absence of intromission, (2) frequencies of intromission and mounts per test, and (3) the number of weeks after castration that any elements of sexual behavior were observed.”¹¹ They found further that experienced males achieved at least one intromission after castration and continued to at least mount for many months. In the first post-operative test only two of six inexperienced castrated males achieved intromission but they never achieved another intromission even though they did continue to mount for several more months. The other four inexperienced castrated males never showed interest in females after the operation. Thus Dr. Rosenblatt and Dr. Aronson conclude, “The results of this experiment led to the conclusion that prior sexual experience functioned to facilitate the continuation of sexual behavior after castration.”¹²

In a similar manner, the sexual reactions of spayed females could

be tested. Undoubtedly any investigator would find that the sexually experienced spayed female cat would show greater sexual response than would the sexually inexperienced spayed female cat.

Thus the sexual responses of all manner of domesticated cats has been qualitatively defined and a description of the catnip response of these same cats can now be examined. The first suggestion that catnip had an odor which stimulated a response similar to sexual response from cats came from Dr. Neil Todd. In his doctoral dissertation Dr. Todd states, ". . . catnip coincidentally mimics a phenomena of the cat which is capable of eliciting or reinforcing specific postural displays of courtship."¹³

Chemical analysis alone doesn't show why nepetalactone, the volatile Oil of Catnip, causes the response it does. Dr. Todd found the catnip response to be a dominant autosomal gene and therefore an inherited trait—therefore some cats are "responders" and some are "non-responders." Dr. Todd explains the ratios of these, "The combination frequencies are approximately 69 for responders (p^2+2pq) and 31 for non-responders (q^2)."¹⁴

Dr. Todd observed similarities between the rolling response caused by catnip and some aspects of the rolling response of the female cat in "heat." Thus Todd thought that the odor of catnip might be similar to the odors of oestrons in some way—perhaps resembling a phenomenon of sex odor. Todd tried to determine if the smell of catnip was similar to an oestrous odor by taking samples of urine from males, anoestrous females, and oestrous females and giving samples of these to two males and two females. There was no response to the female urine and one male and one female reacted to the male urine. But this all proved nothing.

However, Dr. Todd was able to study and analyze the catnip response. He breaks the response down into four basic components, "1) sniffing, 2) licking and chewing with head shaking, 3) chin and cheek rubbing and 4) head-over roll and body rubbing. These components almost invariably appear in the above sequence."¹⁵ Not only did Dr. Todd find these components to occur in that particular sequence, but he also found that all of the components were identical to some aspect of the sexual response though he didn't say which aspect any one of the components was similar to. Dr. Todd also didn't state whether the catnip response was similar to the sexual responses of a male or a female cat. But his testing did show that only very few cats deviate from the normal four component responses to catnip. Three out of fifty-eight of the cats he tested did not show a response corresponding to the "licking and chewing with head shaking" component.

In addition to the basic four components Dr. Todd noticed some occasional added responses to catnip. These additional responses he states and explains, "Additional behavior patterns noted occasionally are claw sharpening and washing, both of which occur as displacement activities in the ethological sense in sexual behavior."¹⁶

On the basis of some further work Dr. Todd was able to classify all cats, according to the quality and quantity of their response into one of two classes. "There appear to be two classes of responders,

partial and total, but it is impossible to separate a possible genetic basis for this from environmental factors without a uniform testing situation.¹⁷

Dr. Todd feels that cats that show only the first component of the normal catnip response—that of sniffing—can be classified as responders if they make a big deal out of sniffing. Dr. Todd also feels that components (1) and (3) lead to further responses while components (2) and (4) are ends in themselves.

Dr. Todd found that cats that only responded to one or a couple of the four components had to be tested again and again until the entire response was exhibited. "Among responding animals the response may occasionally be inhibited for obscure reasons necessitating repeated testing of non-responders before drawing conclusions."¹⁸ (Dr. Todd's three exceptions to this have already been mentioned.) However these results of Dr. Todd's directly contradict the findings of Dr. Palen. Dr. Palen states his findings as follows: "Cats which had been exposed to catnip before, reacted in the same way again, whether they were reactors or non-reactors."¹⁹ And, in fact, the findings of my own investigation correspond to Dr. Palen's finding.

Dr. Todd also classified all kittens under six to eight weeks as non-responders for they all did nothing. Dr. Todd found that at three months the kittens would begin to sniff and explore and then could be classified as responders. However, once again the finding of Dr. Palen and myself contradicted Dr. Todd's finding. Both Dr. Palen's work and my own experiments showed that many kittens under six weeks old could be classified as responders since they sniffed and played and explored as they wouldn't normally at other times. Thus on two counts Dr. Todd seems to have unique results.

Now that the sexual behavior and the catnip response of cats has been examined the results of my experiments can be given. The experiments were conducted with thirty cats—eleven males and nineteen females. Of these twenty-two were given the tests in a 4 x 4 x 4 cage and eight were tested in the house in whatever room they were most accustomed to. On each of four consecutive test days, each cat was administered catnip leaves and allowed to respond for five to ten minutes or until it lost interest.

Where Dr. Todd divided the cat's response to catnip into four components I found it more convenient to divide the response into five components. These components are 1) sniffing, 2) chewing and head-shaking, 3) head and cheek rubbing, 4) head over roll and body rubbing, and 5) self-licking. Whenever all five of these components made up the response of a given cat then they occurred in the order in which they are written. Every one of the thirty cats tested exhibited at least a sniffing response and any cat that exhibited more than just the sniffing component showed them in order even if some components were left out. For example, Petruska did not exhibit a chewing and head-shaking response but went directly from the sniffing component into head and cheek rubbing from which the last two components of the complete response followed in order.

An attempt was made to associate the responses of a given cat

to its sex—male or female—and condition at the time. In other words, the responses of all male stud cats were compared to see if any similarities could be discerned.

In a similar manner other groups were formed which consisted of castrated males, spayed females, kittens, pregnant females, females in heat, females with kittens, and experienced females without any other current conditions. Often some of these groups could also be compared.

Four male stud cats were compared. The responses of Manxy and Sam were identical as were the responses of Regie and Dommie. The latter two of these studs exhibited all five components of the complete catnip response whereas the first two exhibited all except the last component—that of self-licking. Thus the responses of male stud cats can be seen to be nearly identical.

The response of a single unaltered naive male cat was compared to the responses of the four male studs. The difference was plain. Matthew, the naive male, exhibited only the first component of the complete catnip response—that of sniffing—and thus he showed his sexual naivete in his inadequate response to the catnip. Similarly, Lucy, a naive female, exhibited only the first two components of the catnip response and in so doing showed her naivete.

However, the five castrated males presented somewhat of a problem. Three of these—Cookie, Scooter, and Petrushka—had had some sexual experience prior to castration but only Scooter and Petrushka exhibited a catnip response comparable to the response of the four stud cats. Scooter's response was complete, and Petrushka's response skipped only the chewing with head-shaking response. Cookie's response, however, was comprised of only the sniffing component and therefore seemed to make his response more comparable to that of a naive male than to that of a stud. However, there may be an explanation for Cookie's partial response.

Cookie has achieved more intromissions than either of the other two castrated males with pre-operative sexual experience. However, Cookie had never been able to impregnate a female because he had only one testicle and could not achieve an ejaculation. This then could be the reason for Cookie's partial catnip response. Or Cookie may have been a non-responder.

The other two castrated males—Big Jip and Bunny—had had no pre-operative sexual experience. Both these cats showed catnip responses similar to the naive male's responses. Big Jip exhibited the sniffing component and the chewing with headshaking component. Bunny showed just the sniffing component. Thus, the responses of the castrated males correspond, with only one exception, to the responses of the unaltered males.

The responses of the female cats do not show marked similarities as well as the responses of the males did. Six sexually experienced females, which were not pregnant, in heat, or nursing kittens, were tested. Of these six, four—Maverick, Key Key, Diana, and Mi Mi—showed four out of five components of the complete response to catnip. Three of these four did not exhibit the self-licking component and

only one—Key Key—did not exhibit the chewing with head-shaking component of the catnip response. Of the other two experienced females, Zero's response was very similar to the other four females, already mentioned, and Pam's response was totally different.

Zero showed three out of five components of the catnip response instead of four components that the other four females exhibited. The two components of the complete response which Zero excluded were chewing with head-shaking and self-licking. These two responses combined, it will be noted, were the two components which the other four cats didn't exhibit. Thus Zero's response is normal if we consider a three or four component response normal for females. However, we must assume that this normal female response will always include the sniffing and head with cheek rubbing components.

Pam, on the other hand, showed only the sniffing response. Thus Pam's response is not normal for an experienced female if we judge her response by the rule just established. In fact, if we recall Lucy, the naive cat's two component response then we can reasonably say that Pam's response is more comparable to the naive female response than to the experienced female response. There is no reason for Pam's unusual response—except the possibility that Pam could be a non-responder as the castrated male Cookie could have been.

Three spayed females were also tested—Momma, Miranda, and Little Jip. Momma and Miranda both had extensive pre-operative sexual experience whereas Little Jip had none. However, all three of these spayed females showed a normal response—that is comparable to the responses of the experienced females already discussed.

The responses obtained from the pregnant females, females in heat, and females with kittens were spread from single component to five component responses. In the case of the three females with kittens, the responses of the three cats, when compared, were so inconsistent as to make analysis very difficult. The other two groups were somewhat more consistent.

Of the three pregnant females—Georgia, Maive, and Sharon—two exhibited two component responses of sniffing and chewing with head-shaking. Georgia, alone of the three, exhibited a third component in her response—that of the head over roll and body rubbing. Thus the responses of the pregnant females seems to be more comparable to the naive female's two component response (not including head and cheek rubbing) than to the normal experienced female. The indication, therefore, is that female cats when pregnant become naive in sexual response or just can't be sexually excited even by catnip.

The three females in heat—Shazaty, Minnie, and Galva—showed three component responses including sniffing, head and cheek rubbing, and head over roll and body rubbing in two out of three cases. Shazaty responded only by sniffing but there could be a good explanation for her partial response. Within five minutes before her test—on two occasions—she had just completed sexual intercourse and, therefore, the idea of responding sexually to catnip may not have been a very appealing idea of her. The particular three component response of the other two females in heat presents a peculiar problem.

They both showed the sniffing, head and cheek rubbing, and head over roll with body rubbing components. These last two components are similar to two different sexual responses. The head and cheek rubbing corresponds to part of the sexual response of a cat in heat while the head over roll and bodyrubbing component is similar to the sexual response of a female cat after mating has occurred. The question is why are both of these components exhibited by a female in heat?

Only the responses of the two kittens have not been examined yet. Both of these kittens, when exposed to catnip, sniffed diligently for several minutes and then started exploring, playing, or just running around drunkenly. These kittens did definitely respond to the catnip even though their response was only of one component.

The catnip response of every kind of cat has now been seen. It might be added here that the cats tested included Persians, Manx, Siamese, and Alley cats. Summary and emphasis of a few points must be made before we go on.

We have seen that the normal catnip response of a sexually experienced male cat, whether castrated or not, is composed of four or five components of the total five component response. The sexually experienced females were seen to show three or four components of the total response—whether they were spayed or not. The sexually naive males and females, altered or unaltered were seen to respond to catnip by showing only a one or two component response.

Several things must be noticed about the catnip responses. All the cats exhibited at least the sniffing component of the catnip response. Naive cats or sexually inexperienced altered cats rarely showed more than the sniffing and chewing with head shaking components. And the sexually experienced cats, whether altered or not, always showed at least three components of the five and usually exhibited four or five of the total number of components.

It must be noticed, however, that the sexually experienced cats always exhibited the head and cheek rubbing component along with the more elementary sniffing component and chewing with head-shaking component. Then the sexually experienced cat also may exhibit the head over roll and body rubbing component and then the self-licking component, but neither of the last two would be part of the cat's response if it had not previously shown the head and cheek rubbing component. (Georgia was the only exception). The cheek and head rubbing component was always the third component to be exhibited in the normal sequence. Naive cats never reached this third component of the catnip response and sexually inexperienced cats rarely reached the third component.

Next we must determine the significance of each component of the catnip response. I would now ask the reader to recall the explanation of the sexual act of cats remembering every position and posture. Also recall that Dr. Todd broke the catnip response into four components whereas my results required five. Also recall Dr. Todd's words, . . . catnip coincidentally mimics a phenomena of the cat which is capable of eliciting or reinforcing specific postural dis-

plays of courtship." The important words to remember from this quote are "... postural displays of courtship."

The first component—that of sniffing—was exhibited by every cat. This component is easily explained as an inquiry into an exciting or stimulating smell. Often a lot of time was spent sniffing and was not followed by another component of the response immediately or at all.

The second component followed the sniffing component and is best described as chewing and head-shaking. This is the component of the catnip response upon which Dr. Todd and I disagree. Dr. Todd describes the second component as, "... 2) licking and chewing with head shaking . . ." If by "licking" Dr. Todd means licking the floor or plate where the catnip leaves were, then this is a reasonable part of the component. However, if this is his meaning then he has left out a component of the response—that of self-licking which is the last in the sequence. Or if by "licking" Dr. Todd does mean self-licking then he has misplaced it for it is the last component of the sequence.

Thus, the second component of the catnip response is that of chewing with head-shaking. In this part of the response the cat eats the catnip leaves. The chewing is an obvious part of the process. The head shaking really is also an integral part of the chewing process, not—as some researchers feel—an added effect of catnip. The head shaking is merely an effort by the cat to shake off catnip leaves which have become caught in the fur of the lower jaw. Admittedly the head shaking isn't violent but the cat probably by this time really just doesn't care about anything except the stimulating smell.

By the time the stimulating smell of the catnip takes hold of the sexually experienced cat the chewing with head shaking component ends and the cat usually goes right into the third component—that of cheek and head rubbing. Sometimes, however, the cat will skip over the third component and go right into the fourth component. If this happens it will not follow the fourth component of the response with the third. The cat never skips from the second component to the last one.

The third component of the catnip response is partly a "... postural display of courtship" but can't really be considered a complete display of courtship. In the head and cheek rubbing component of the catnip response the cat is standing upright with its forelegs bent just enough to allow it to rub its head and cheeks on the floor or against a wall or post. This component is a "... postural display of courtship" in so far as the head and cheek rubbing goes, for female cats in heat rub their cheeks and head continually. However, the female cat in heat, it will be recalled, puts her forelegs on the floor, arches her back in lordosis, and raises her back in the air—the female cat responding to catnip does none of these. In addition, male cats displaying the third component respond exactly as the females do; yet the male cats never make any "... postural display of courtship" except when influenced by catnip and then it is not a display of courtship but rather a reaction to the catnip.

The head over roll and body rubbing component is fourth in the

total sequence. It is not ever a "... postural display of courtship" for the simple reason that courtship comes before sexual intercourse and not after. In the sexual response of experienced cats head over rolls and body rubbing occur immediately after intercourse and never before. Also, the sexual response of male cats never includes head over rolls or body rubbing. Thus since even for females the fourth component is an after-mating reaction it can't be described by a word which describes a pre-sexual intercourse condition.

Finally, the fifth component is that of self-licking. This cannot be considered a "... postural display of courtship" since self-licking also follows sexual intercourse. In addition, the self-licking of the catnip response is licking of the forearms and paws whereas the self-licking of the sexual response is licking of the perineal region.

Certainly the catnip response isn't a "... postural display of courtship." We see that even though the catnip response looks more like parts of the sexual response than anything else, it really isn't as similar as it seems.

In fact the catnip response seems to be unique as the sexual response in a wholly different way. Sexual intercourse doesn't elicit half the response from the male cats as catnip does, and the responses of females to sex and catnip are as different as they are similar.

¹Gary F. Palen, *Animal Behavior*, 1966.

²S. M. McElvain, *Journal of the American Chemistry Society*, 1941, 1942, 1954, 1955.

³Jerrold Meinwald, *Journal of the American Chemistry Society*, 1954.

⁴Meinwald, 1954.

⁵Richard E. Whalen, *Animal Behavior*, 1963.

⁶J. S. Rosenblatt, *Behavior*, 1958.

⁷J. S. Rosenblatt, *Behavior*, 1958.

⁸R. E. Whalen, *Animal Behavior*, 1963.

⁹R. E. Whalen, *Animal Behavior*, 1963.

¹⁰R. E. Whalen, *Animal Behavior*, 1963.

¹¹J. S. Rosenblatt and L. R. Aronson, *Behavior*, 1958.

¹²J. S. Rosenblatt and L. R. Aronson, *Behavior*, 1958.

¹³N. B. Todd, Doctoral dissertation, 1963.

¹⁴N. B. Todd, *Journal of Heredity*, 1962.

¹⁵N. B. Todd, *Journal of Heredity*, 1962.

¹⁶N. B. Todd, *Journal of Heredity*, 1962.

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¹⁸N. B. Todd, *Journal of Heredity*, 1962.

¹⁹G. F. Palen, *Animal Behavior*, 1966.

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