3 m away, (iii) a 90-cm cube 1 m away, and (iv) the 90-cm cube 3 m away. For group 3, angularly equivalent projections were used. Each stimulus was presented for four 30-second periods in counterbalanced order. The number of responses elicited by each was tallied. No reinforcement was given during testing.

Presentations ii and iii were differentiated from i, the conditioned stimulus, by all three groups (Table 1). This discrimination could be made on the basis of changes in the size of the retinal image. The differentiation of iv from i, where the retinal image size of the cubes was the same, was accomplished only by groups 1 and 2 ($t = 14.97, 16.02$; $p < .001$). Presentation iv elicited the smallest number of responses from groups 1 and 2, a fact which I interpret to mean that these infants could not only detect changes in spatial position but could also detect size at a distance. That is to say, they manifested size constancy. Group 3, on the contrary, failed to differentiate presentation i from presentation iv ($t = .097$, not significant).

The implications of these data are clear. Both presentations i and iv, as seen by group 3, were rich in pictorial cues which were quite sufficient to specify to the adult eye that the cube in iv was further away and larger than the cube in i. Relative height on the projection screen, density of table texture at point of contact with the cubes, density of wall texture occluded by the cubes, and linear perspective of table to point of contact with the cubes were some of the available variables. Only the angular size of the two cubes was the same. This rich array of pictorial cues was quite insufficient for the infants in group 3 to be able to discriminate the distances and the sizes of the objects placed at different distances. Their responses were apparently controlled by the angular size of the cubes alone. This single cue sufficed for the discrimination of ii and iii from i, but its limitations are shown up by this group's failure to discriminate iv from i. The static monocular array of a picture apparently conveys no information about the distance and size of an object presented at a distance to infants of this age.

The performance of groups 1 and 2 was markedly different, manifesting some degree of size-constancy. Group 2 also had a monocular array, but for them it was not static, frozen onto a picture plane, as for group 3. The difference is the availability of motion parallax. For this group every head movement produced relative displacements of every object in the visual field, nearer objects being displaced further, faster, and in a direction opposite to farther objects. This conglomeration of variables obviously conveyed sufficient information for the discrimination of i from iv. Group 1 had binocular-parallax available in addition, but, since their performance was not better than that of group 2, it may be concluded that, while motion parallax is necessary for the discrimination of angularly equivalent but objectively different sizes by 50- to 60-day-old infants, binocular parallax is not. Whether or not motion parallax is sufficient as well as necessary is not an issue which can now be decided.

It may be argued that these infants were responding to motion parallax itself, rather than distance and size as specified by motion parallax. This objection has some face value but is operationally meaningless. A system which responds to motion parallax itself is isomorphic, in the full sense of the word, with one which responds to size and distance as specified by motion parallax. On no perceptual task can the two systems be other than identical.

These data have some interesting implications for theories of the development of perception. The fact that motion parallax is the necessary variable for space perception in infants allows one more precision in theorizing about the relation between perception and action (*3*). An active observer creates for himself a whole system of potentially informative transformations of the optic array (*4*). As we have seen, one of these, motion parallax, is sufficient for young infants, while an untransformed array is not. The performance of group 3 is especially interesting since this group did not even differentiate presentations i and iv, much less give any indication of a space-specific response. This indicates that the available variables had not even been detected, much less become informative. If a like process of discrimination learning (*5*) occurs earlier with motion parallax, as seems likely, the deleterious effects of enforced inaction on perceptual adjustment (*3*) become more comprehensible. With no opportunity to produce transformations, a subject cannot begin to discriminate these transformations.

As for later learning, the discrimination or detection of static pictorial variables may be followed by correlation of them with the more primary parallax variables.

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Cerebral Temperature Changes Accompanying Sexual Activity in the Male Rat

Abstract. *Cerebral temperature was continuously recorded in male rats during sexual activity. The temperature showed a persistent increase in the presence of females and a relatively brief, rapid increase during sexual intromission. Cerebral temperature may be usable as a sensitive measure of immediate and persisting motivational effects of transitory and long-term conditions of stimulation.*

Changes in intracranial temperature accompany behavioral changes from sleep to wakefulness and responses to alerting stimuli (*1*). Such measurement of temperature is relatively simply made and provides a sensitive measure of change in the motivational state of the animal. We now report on temperature changes, measured by a thermistor implanted in the cerebral cortex of the male rat, recorded continuously before, during, and after sexual activity.

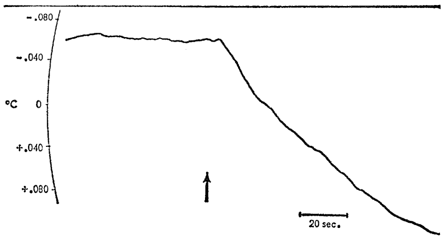

Fig. 1. Change in cerebral temperature of a male rat resulting from introduction of a female (at arrow) into same enclosure; downward deflection represents increase in temperature.

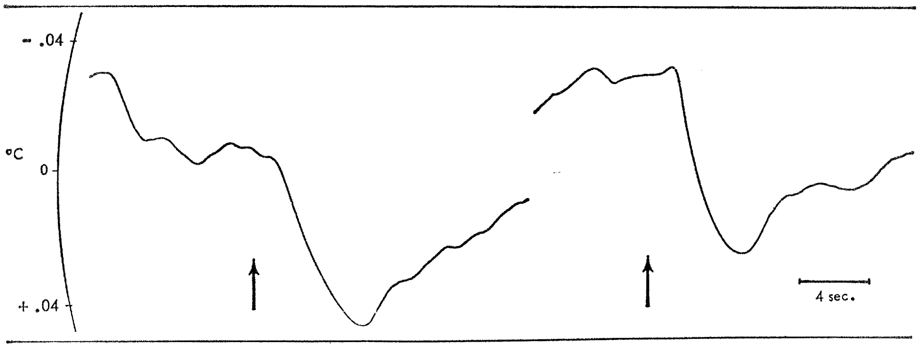

Fig. 2. Change in cerebral temperature resulting from sexual intromission. Arrows indicate approximate beginning of intromission; the two successive responses shown were separated by 1 minute.

Thermistors (YSI type 44005) were permanently implanted in the lateral convexity of the cerebral cortex of the rat at a depth such that the entire thermistor disc was inserted beneath the dura. The thermistor leads were soldered to a two-pin female connector, and the whole assembly was affixed to the skull with dental acrylic. Female rats were oophorectomised and artificially brought into oestrus for the day of recording. For measurement and observation the male rat was placed in a circular arena, having clear plastic walls and a wire-mesh floor, about 2 feet (60 cm) in diameter. Temperature was measured by using the thermistor as an arm of a conventional Wheatstone bridge; recordings, made on an Offner type-R ink-writing oscillograph, were initiated 1 to 2 weeks after implantation of the thermistor. Temperature recordings improved and sexual activity increased with time after the implantation (*2*).

On the day of recording, a male was allowed 10 to 15 minutes for habituation to the arena before a female rat in oestrus was introduced. The temperature in the male's cortex increased steadily for one to several minutes; the rats' behavior during this time consisted of mutual examination —sniffing, licking, and so on. This increase in temperature (Fig. 1) could best be characterized as resulting from the newcomer serving as a "social stimulus," since comparable increases were caused by introduction of other males or of females not in oestrus.

The mean increases in temperature for five males during 4-minute periods immediately before and immediately after the female was introduced in the arena, and during a similar period immediately after the female was removed, were, respectively (standard deviations are in parentheses): 0.021° (.109), 0.379° (.199), and −0.171°C (.071); the differences are statistically significant beyond the 0.01 level of confidence (*F*, 39.61; degrees of freedom, 2.8).

Further increases in temperature occurred when the male attempted to mount the female or actively pursued her around the arena. Although these temperature increments may have been directly enhanced by the generally increased activity, they also preceded the increase in activity. During a period when a male rat was inactive, we could predict the renewal of activity from increase in temperature before the activity began.

Conventionally, the copulatory activity of the male rat divides into three components: the male mounts the female without achieving penetration; the male mounts and achieves penetration, which is followed by a series of rapid thrusting movements (intromission); the male ejaculates after 8 to 15 intromissions, after which sexual activity ceases for periods of 5 to 10 minutes. If the male mounted without intromission, there was no systematic change in temperature. If the male made an intromission, there was a small but invariable increase in temperature (Fig. 2). The latency of the onset of increase varied from 1 to 2 seconds, as nearly as we could estimate; the "time constant" of the thermistors was too variable for more accurate estimates. For the total of 120 intromissions by five males, the mean and standard deviation of the increase in temperature were 0.026° and 0.015°C, respectively. In general, ejaculation had no effect on the increase in temperature that accompanied intromission. In one rat there was progressive increase in the degree of temperature changes that accompanied a series of intromissions leading to ejaculation. In three other rats there was no such relation; the temperature increment was smaller with the terminal intromission than with others in the series leading to the ejaculation.

After ejaculation, temperature slowly decreased for varying periods until the rat again initiated sexual activity. Law has reported increases in heart rate during 20-second intervals after each of the components of sexual activity (*3*); he found that this measure reliably differentiated only the ejaculatory component from the other two. That the temperature of the brain is apparently more sensitive to the intromission component suggests that the effects of different physiological processes are being measured.

The physiological basis for the temperature changes we report cannot be stated unequivocally. Heat produced by increased brain metabolism, changes in blood temperature, or changes in cerebral blood flow, separately or in concert, may have produced these effects. As suggested by Betz (*1*), the most plausible of these factors is cerebral blood flow. So long as the arterial pressure of the body remains above a critical level, cerebral blood flow is regulated to a high degree in the brain itself (through neural and humoral control of cerebral vascular tone) and may well indicate local changes in metabolism of the brain (*4*). As such, cerebral temperature may represent an integration of brain processes which can be used to measure immediate and persisting motivational effects of transitory and long-term conditions of stimulation.

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