Diving Depths of the Weddell Seal

Abstract. *Dives as deep as 350 meters have been recorded for the Weddell seal in the waters of McMurdo Sound, Antarctica. It is suggested that Weddell seals possess a well-developed navigational system which enables them to swim long distances under thick ice shelves where light and breathing holes are limited.*

The depths to which most species of seals dive have generally been inferred from the presence of drowned seals in fishing nets set at known depths and from the finding of seals caught accidentally on hooks of set lines (*1*). However, diving depths for the bladdernose seal, *Cystophora cristata* (Erxleben), and the grey seal, *Halichoerus grypus* (Fabricius), have been measured by attaching to the seals capillary tube manometers (*2*). An estimate of diving depths for Weddell seals was determined by assuming that a mature male dived to 95 m while swimming under an ice barrier to reach an isolated crack in an ice shelf (*3*). Diving depths reported in this paper have been measured by a depth recorder attached to the backs of Weddell seals, *Leptonychotes weddelli* (Lesson).

The extreme south end of McMurdo Sound is an excellent area in which to observe the behavior of Weddell seals. The Ross Ice Shelf bounds that part of the sound and forms a barrier to further southern movement of the seals, while the sea ice has many cracks through which seals can leave the water. During November seals gather in small rookeries near these cracks and remain in the immediate vicinity until the sea ice breaks up in February or March. This area (77°54′S, 166°40′E), approximately 3 km south of the U.S. base at McMurdo Sound, can easily be reached on foot or by surface vehicle.

On 13 November 1962, a mature female, lying on the ice near a crack, was roped and a Tsurumi Seiki depth recorder with a range of 0 to 500 m was fixed to her back with strips of rawhide. After 2 days the seal was recaptured and the smoked-glass slide, on which the depths had been registered, was replaced. After another 2-day period the depth recorder was removed and attached to a second mature female. Three 48-hour series of dives were obtained for the second seal. Depths of dives for both seals are listed in Table 1.

The record of depths for any 48-hour period shows that the seals were swimming in both shallow and deep water, but not at the greatest depths (500 m) possible in this part of McMurdo Sound. Although the slide recorded only two or three deep dives, it indicated numerous shallow dives at approximately the lower edge of the ice shelf.

Table 1. Depths for 48-hour series of dives.

Slide No.	Dives (m)		
	Maximum	Mid-water	Shallow*
	Animal No. 1		
407-A	335	285	25
407-B	350	320	20
	Animal No. 2		
408-A	320		20
408-B	305		20
408-C	295	235	25

* Several dives were made in each instance.

These recordings may explain in part how Weddell seals have reached many inland cracks in the Ross Ice Shelf. During the summer of 1958–59, Weddell seals were reported in the vicinity of tidal cracks near White Island which is 22 km inland on the ice shelf (*4*). In the summers of 1961–62 and 1962–63 several seals were observed, 58 km back from the leading edge of the ice shelf, in a tidal crack at the foot of the Koettlitz Glacier. During the month of April 1962 the Koettlitz Glacier tidal crack froze and there was no evidence that any seals remained in the area with the onset of winter. Weddell seals have also been observed in a large rift near Roosevelt Island (79°30′S, 162°W). This rift is approximately 32 km back from the leading edge of the ice shelf and is about 30 km long. The widest part of the rift is about 1.5 km and the walls are sheer cliffs. The bottom is filled with sea ice in which there are many seal holes (*5*). The shelf ice in this area is approximately 200 m thick, but the evidence that the Weddell seal can dive to depths of 350 m supports the thesis that seals could enter this rift by swimming under the ice shelf. Conditions encountered by seals diving under the ice shelf can hardly be suitable for visual navigation; light does not penetrate the thick ice, and cracks through which seals can surface for air are limited. Furthermore, it has been estimated that Weddell seals can swim only 2.2 km in an average dive of 10.5 minutes (*6*). If Weddell seals are to enter the rift successfully by swimming the 32-km distance under the ice shelf, then they must possess a well-developed navigational system to enable them to find open cracks along the route.

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Maternal Deprivation: Its Influence on Visual Exploration in Infant Monkeys

Abstract. *Visual exploration was studied in maternally reared and maternally deprived monkeys. When an animal pressed a bar an opaque screen was raised providing a brief view of either of a pair of stimuli. Subjects reared by their mothers pressed more to see animate than inanimate objects. With increasing age, the number of bar-pressing responses decreased for an adult female stimulus, increased for an age peer and for food, and remained low for geometric forms and an empty chamber. Maternally deprived subjects established uniformly low response levels to all stimuli.*

Butler (*1*) has shown that adult monkeys, placed inside a small dimly lighted chamber, will persistently open a hinged wall-panel for no incentive other than the opportunity to observe briefly various objects placed outside the chamber. It has been demonstrated further by Harlow (*2*) that young monkeys, separated from their mothers at birth and reared on mother surrogates, will learn to press a bar so that the artificial mother can be seen. However, little is known concerning the early visual preferences of infant primates entirely deprived of their mothers during development. In this study we attempted to investigate the relative influence of maternal rearing as opposed to maternal deprivation on visual exploratory behavior in the infant macaque.

Nine infant monkeys were randomly assigned at birth to one of two groups. Group 1 consisted of four infants reared by their mothers, and group 2 consisted of five maternally deprived animals. Shortly after birth, each infant in group 1 was taken away for a physical examination, but was immediately afterward returned to its mother which was collared and chained to the cage so that the infant could be retrieved for testing. Each infant in group 2, however, was separated permanently from its mother, housed in an individual cage, and handled only for purposes of feeding and examination.

The test apparatus was a modified version of a unit designed at the University of Wisconsin (*1*) and consisted of an enclosed chamber containing two large distinctively painted bars, each located on opposite interior walls. Each press of the bar by the subject constituted a response which caused a motor-driven panel located directly above its respective bar to be raised for 10 seconds permitting a view of, but no manual contact with, the contents of a small booth adjoining each door.

Stimuli were presented in pairs as follows: (i) both stimulus booths empty (control conditions, EE); (ii) empty versus food (EF); (iii) empty versus age peer (EP); (iv) empty versus adult female "mother" (EM); (v) empty versus plastic geometric forms (EPl); (vi) food versus geometric forms (FPl); and (vii) adult female (mother) versus age peer (MP).

The stimulus presentation schedule was designed so that the subjects received all paired combinations during the test period according to a prearranged schedule. After a 3-day adaptation period in the test chamber for all subjects (bars removed), each pair of stimuli was presented once during a series of consecutive 3-week periods. Ten presentations were made for each condition described above so that the period of development during the test schedule covered approximately the first 8 months of life. Although the location of the stimulus-viewing panels was such that there was no clearly definable "right" or "left" side, preliminary data indicated small nonsignificant preferences in almost all animals for one bar over the other in the initial control (EE) condition. Consequently, for all stimulus presentations, objects from each pair were varied randomly from side to side, with the provision that each booth location was sampled half the time.

The preference data for the seven

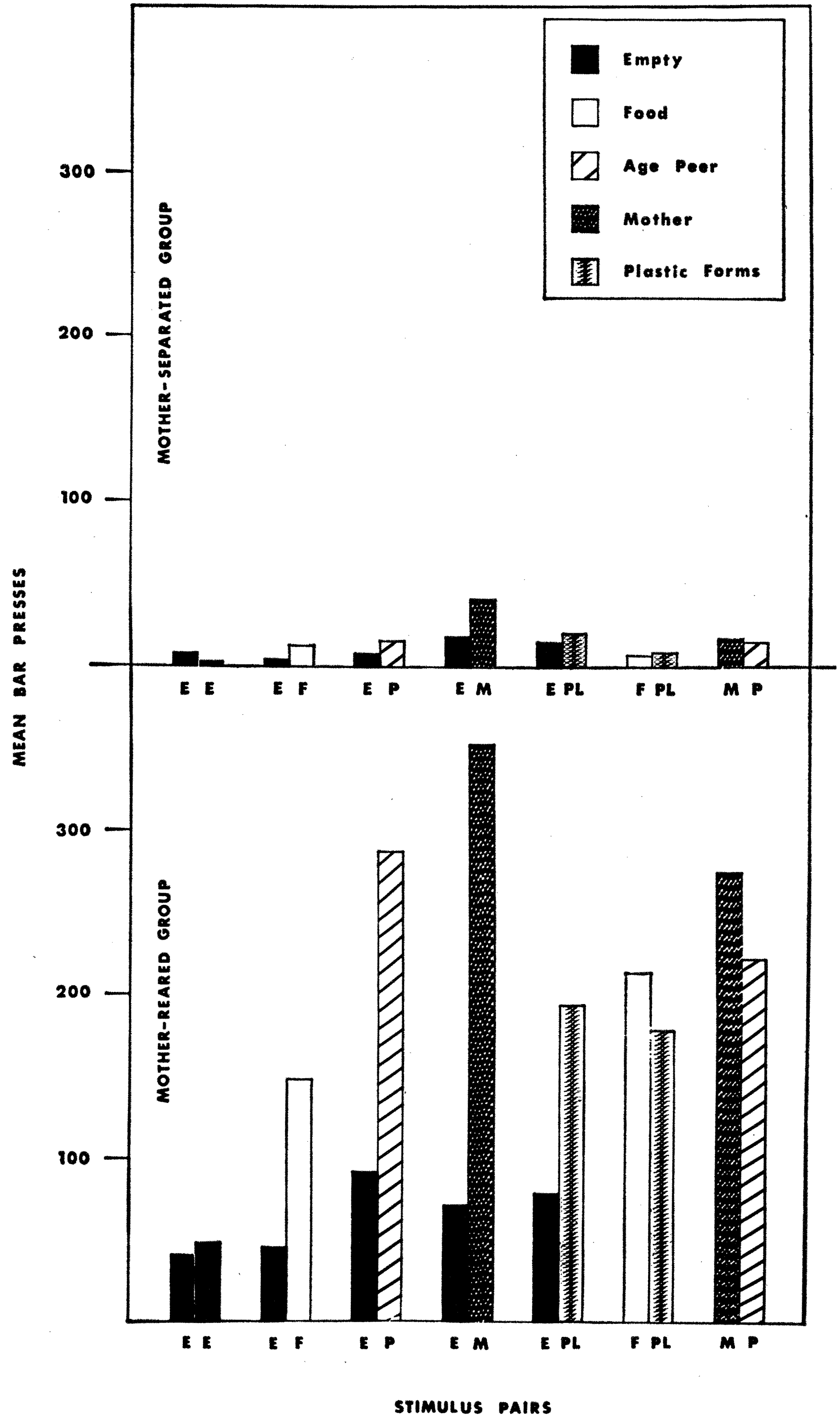

Fig. 1. Mean bar-press responses of group 1 (mother reared) and group 2 (mother separated) during ten 1-hour test sessions for each stimulus-pair condition.

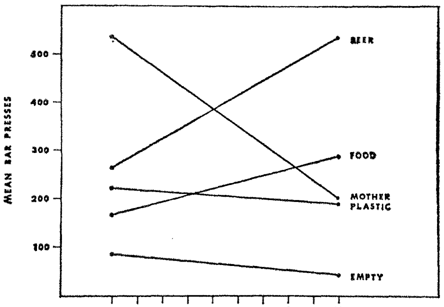

Fig. 2. Best fitting linear functions plotted for each stimulus condition over test sessions (group 1, mother reared, only).

stimulus-pair conditions, averaged over the 30-week test period, are presented in Fig. 1 (*3*). Differences in response rates between groups 1 and 2 were highly significant ($p = .005$, Mann-Whitney U test) on all stimulus pair comparisons. For the control condition (EE), both groups pressed the bars at relatively low but equal rates. For the remaining pairs of stimuli, however, the animals in group 1 maintained high response rates and demonstrated clear preferences, with food being preferred to the empty booth ($p = .02$), age peer to empty ($p = .01$), adult female to empty ($p = .01$), and adult female to age peer ($p = .05$). The preference for food, when paired with geometric forms, fell just short of significance and suggested that these stimuli were about equally attractive.

Response rates in group 2 were uniformly low for all stimulus combinations. The moderate rates seen in this group on the EP, EM, EPl, and MP pairings are misleading since the average number of responses for these pairings increased only toward the end of the experimental series when the animals were somewhat older; responses were virtually absent during the earlier period of testing. With the possible exception of condition EM, whose difference lacked significance, this group showed little evidence for stimulus preferences among the various conditions.

It was also of interest to trace performance changes to the individual stimulus conditions as a function of age. Although the data for the maternally separated group could not be evaluated statistically because of the low response rates, these trends are presented for the maternally separated group in Fig. 2. To minimize the effect on the data of a competing stimulus, only those conditions were chosen in which the paired stimulus for "mother," "peer," "geometric forms," and "food" was the empty condition.

The results indicated that standard deviations were proportional to the means. Accordingly, all data were subjected to a logarithmic transform and best fitting linear functions were determined for each pair of stimuli over the ten test sessions. The responses to adult female and peer stimuli showed opposite trends, namely, with increasing age maternally reared subjects showed an apparent decrease in interest for the adult female and a corresponding increase for the age peer. Geometric forms and food reflected generally lower response levels, with levels for the former showing little change, while those for the latter showed an increase corresponding to a normal transition from liquid to solid food at about 2 months of age. The empty booths, as expected, attracted the least attention. The means of the first five test sessions were compared with those of the last five test sessions by T-tests, which indicated significant differences on the "peer" and "mother" conditions ($p \leqq .04$). None of the other stimuli showed significant changes.

It is clear that early in development maternally reared infant monkeys establish a hierarchy of visual preferences for a variety of stimulus objects. Of those used in this study, the adult female was the most attractive to all infants in group 1, particularly during the early stages of development. Although none of the subjects possessed sufficient neuromuscular development to press the bars effectively before the 3rd week of life, this response was well established after the 5th week. The intensity of preferences changed considerably with increasing maturation and followed a trend toward progressively fewer responses to the adult female, more responses to the age peer, and relatively fewer responses to the inanimate objects.

Maternally deprived monkeys showed few responses to any stimulus compared with maternally reared animals, despite a comparable number of adaptation trials. These animals showed evidence of exaggerated fear and general inappropriateness of response throughout testing. In a typical trial, after several minutes in the experimental chamber, a deprived animal would visually sample each stimulus booth, retreat to a corner of the test chamber, and crouch almost continuously, exhibiting repetitive stereotyped movements such as rocking, hair-pulling, clasping, and "fear" vocalization. These nonadaptive responses emphasize the importance of mothering during the development of adaptive modes of behavior.

It is recognized that the variable of maternal deprivation is a complex one. The relative contributions of maturation, learning, and motivational variables to development of visual responses in the infant monkey must remain conjectural until more experimental evidence is available.

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Distance Perception in Darkness

Abstract. *Human subjects viewed round stimuli located equidistantly in the horizontal and vertical planes of vision under conditions where presumed cues to size were present and where they were systematically eliminated. Two experiments revealed a consistent tendency for the horizon object to be judged the closer. Cues introduced reduced the effect.*

The experiments described in this report began with attempts to induce the moon illusion indoors and to systematically vary some of the cues which were assumed to affect this illusion (*1*). The cues varied were the interposition of a city skyline silhouette between the subject and the moon stimulus and the placement of a blue phosphorescent