increases in the probability that this object occurs as part of the stimulus field in the subject's overall repertoire of responses. Although this seems a reasonable approach, the present data present some difficulties for this view. During rearing, the monkeys in group A did not have the same opportunity to learn the characteristics of other monkeys as did the monkeys in groups B and C. Yet, the monkeys in group A did prefer each other to the alternative choices available. Thus, it is possible that the preference shown by group A monkeys was not based on the conditioning of approach behavior to specific social cues, as is suggested by the stimulus-sampling theory of attachment. It is possible that the behavior of group A was motivated by avoidance of cues contained in the social behavior or countenance of the other two types of monkeys. Thus, there may be at least two distinct kinds of processes in the choice of a social stimulus. The conditioning of specific social cues to the response systems of an animal may be one factor, and the avoidance of nonconditioned cues may be a second important factor in the formation of social attachments.

The specific cues used by the monkeys studied here are not known. Neither do we yet know how our animals differentiated between the stimuli. The discrimination may be based solely on differences in the gross activity of the stimulus animals, or on more subtle and specific social cues. Analysis of the specific stimulus components operating in this situation may clarify the nature of the social cues involved. The important question to be answered is whether the types of cues used in selecting a partner are qualitatively different for different rearing conditions, or whether the same aspects of stimulation are simply weighted differently as a function of an animal's rearing history.

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Mercury: New Observations of the Infrared Bands of Carbon Dioxide

Considerable interest has attached to reports by Moroz (*1*) that the absorption bands of CO_2 at 1.57 to 1.61 μ are enhanced over those in the spectra of the sun and moon. Spinrad *et al.* (*2*) observed the spectrum of Mercury at high dispersion in the region of the weak $5\nu_3$ CO_2 bands in order to determine an abundance value independent of pressure broadening which affects the bands at 1.57 to 1.61 μ. The weak bands were not detected, but an upper limit of 57 meter-atm of CO_2 was established. Then, in order to account for the enhancement found by Moroz, Spinrad *et al.* noted that a surface pressure greater than 3.3 mb is required. The observations of Spinrad *et al.* require that the partial pressure of CO_2 be less than 4.2 mb.

We traced the 1.6-μ bands of CO_2 in the Mercury spectrum on 26 August 1966, using the 61-inch (1.5 m) reflector of the Lunar and Planetary Laboratory of Catalina Observatory and the infrared spectrometer described by Kuiper *et al.* (*3*). Our spectra have a resolution ($\lambda/\Delta\lambda$) of about 500, which is three times that of the Moroz spectra. Mercury was observed at relatively small zenith angles (22° to 43°), and solar comparisons were made at similar zenith distances on the same day. Care was taken to fill the optics in the same way for both Mercury and solar observations, and the same slit dimensions were used. Sunlight was diffusely reflected from a smoked MgO screen.

From our observations the equivalent widths of the 1.57- and 1.61-μ bands are 12.5 ± 1.9 Å and 10.0 ± 2.3 Å, respectively; while for the solar comparisons the equivalent widths are or 12.4 ± 0.7 Å and 10.5 ± 0.8 Å. Thus, within the error of the observations, there is no evidence here of a carbon dioxide atmosphere on Mercury.

We would emphasize that these observations are difficult and that we have far fewer individual tracings than Moroz does, though ours have higher resolution. Our results are to be regarded as preliminary, as many more tracings of these bands are needed (*4*).

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Homing in Pigeons

From data gathered by following individual pigeons during flight, Michener and Walcott [*Science* **154**, 410 (1966)] reason that their pigeons could not have been homing by use of landmarks alone and that their results "strengthen the conclusion that pigeons do not pilot most of their courses by familiar landmarks, even over landscape that they cross frequently." I think their data support the opposite conclusions.

The circuitous tracks flown by their pigeons and the frequent correspondence between consecutive tracks indicate use of landmarks. No highways are shown on their maps, but, when I compared them with my roadmap, 9 of the 11 tracks reported follow major highways, often quite closely; half of another follows the Merrimack River. Only one seems not to follow prominent landmarks; half of this curving track was repeated by the same bird on its next flight. Ten tracks refer to one pigeon; this bird's 21 earlier training flights were not followed, and during these it could have accumulated a knowledge of many landmarks, including "unfamiliar" Worcester. Minor variations in tracks from flight to flight can occur when the same landmarks are used; major variations suggest use of different sequences of landmarks.

During overcast the birds observed by Michener and Walcott did not fly when released more than 10 miles (16 km) from the loft (six releases of unknown individuals were reported), but they cite flocks homing "routinely" from greater distances under overcast. Why should one think that pigeons in flocks use navigational cues different from those used by lone pigeons?

All of Michener and Walcott's data suggest that their pigeons were using landmarks at all times when homing. No evidence is presented to show that the sun had any effect other than what they observed—that is, of stimulating the birds to take off or keep flying. That this effect varied with distance suggests a correlation with the birds' degree of familiarity with the landscape.

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Murray raises several points that we will discuss in order: (i) Did the tracks follow prominent landmarks, especially highways? (ii) Did the birds know the landmarks throughout the area, including Worcester? (iii) Do all our data suggest that our pigeons used landmarks at all times?

One pigeon's (Blue's) five consecutive training-point tracks began at Fitchburg Airport, and four of them passed through the same valley as the major highway, Route 2, which extends eastward to Boston. Most of the tracks clearly crossed various roads without reorienting to them, but how close must a pigeon fly to a major highway in order to see it? Route 2 forms a gap about 150 feet (46 m) wide in the otherwise hilly, forested area. The pigeons we observed almost always flew within 100 feet of the treetops. If the trees were 50 feet tall and the highway 150 feet wide, a pigeon flying as high as 250 feet above the ground could see the roadway only when less than 750 feet (1/7 mile or 0.23 km) from it. These calculations were confirmed by direct observations from aircraft 1000 feet above the ground: it was nearly impossible to see Route 2 when only ¾ mile from it, even when we knew exactly where to look.

In our report we mentioned several definite reactions to landmarks, including those near the Merrimack River. We concluded that our pigeons did orient by landmarks within 10 miles of the loft, but at greater distances (including releases from Worcester) three different kinds of evidence suggest that birds do not respond to previously encountered landmarks:

1) When Blue was released the second time from Worcester, it flew south, parallel to its previous three courses from another release point. Had it learned this major city on its release 14 days earlier it should have flown toward the loft at least as well as it did on its first flight. Instead, it departed 80 deg from the home direction.

2) On three occasions, pigeons released from new places flew incorrect courses, on which they passed through the region directly between Fitchburg and the loft. As they crossed their previous tracks, they turned neither more toward home nor more toward their previous paths.

3) In all cases when the sun was obscured by clouds and the pigeons were more than 10 miles from the loft, each bird perched and did not resume flying until the sun became visible again. Hitchcock (*1*) found that his pigeons homed under total overcast, and our recent results show that pigeons trained on overcast days will fly home, but they take between 10 and 50 times longer to cover a given distance.

These three points suggest that our pigeons do not use landmarks alone to find their loft.

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Optical Environment in Gemini Space Flight

In their report [*Science* **153**, 297 (1966)] Ney and Huch conclude from Fig. 1 that the first-magnitude stars are at threshold of visibility with a background luminance of the order of 10^{-8} of the sun's surface brightness [10^{-8} ssb is approximately equal to 6 mlam (5.6 ft-lam)]. Since the space sky is much darker and also since the corona of the spacecraft does not raise the background luminance to and above this limiting level, the authors assume that the scattered sunlight and earthlight in the window of the spacecraft are responsible for the background luminance that makes the stars invisible. Argyle, in his comment, calls our attention to a very important factor, namely, scattering within the eyes of the observer. I would like to add some explanatory remarks: sunlight or earthlight, when acting as a source of glare, produces a veiling luminance within the eye which adds to that of the sky and of the stars, thus diminishing contrasts and also decreasing the light sensitivity of the eye. I do not agree with Argyle's statement that the disturbing illuminance at the eye should be at least 1000 lux (100 ft-c), since a much lower illuminance would be sufficient in case the glare angle is small. When sun or sunlit earth is out of view, the disturbing effect will not stop immediately, as in Argyle's example with the street lamp, but recovery to the previous level of sensitivity will require some time, depending on luminance, duration, and position of the glaring light.

Light sensitivity of the eyes is a fundamental factor when one is observing lights of near-threshold intensities. When the astronaut shifts his gaze from some illuminated area, for example, the interior of the space capsule, toward the dark sky, he should wait a few minutes in order to increase the sensitivity of his eyes. The conical sunshade on the viewing window, suggested by Argyle, would definitely help to avoid veiling glare in the eyes and scattered light in the window, although it would restrict the field of view.

I would like to emphasize that the curve of Fig. 1 derived by Ney and Huch from Tousey's paper is valid only when the eyes are perfectly adapted to the background luminance. When the eyes are adapted to a background of 10^{-8} ssb, first-magnitude stars can be perceived by the foveal region only, whereas the periphery of the retina is not sensitive enough. Therefore, it would be difficult to locate weak lights at this stage of vision when the observer does not know exactly where to look.

The authors do not discuss the losses of intensity through the window of the spacecraft by absorption and by reflection, which may be appreciable depending on the material, the multilayered structure, and the inclination of the window to the line of sight of the astronaut. A loss in intensity of a star would lower the required background luminance for its visibility at threshold and would require a longer adaptation time. In case there are inhomogeneities (for example, by scattering) the "noise level" of the window may contribute to the difficulties in perceiving stars during daytime in space.

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