Defensive burying as a function of food and water deprivation

STEPHEN F. DAVIS, MARK HAZELRIGG, SCOTT A. MOORE, and
MARY K. PETTY-ZIRNSTEIN

Emporia State University, Emporia, Kansas 66801

Three groups of albino rats were tested for defensive burying behavior under conditions of food deprivation, water deprivation, or satiation, respectively. Satiated subjects accumulated significantly more bedding material around the aversive stimulus and spent significantly more time engaged in defensive burying than did food- and water-deprived subjects. These results are compared with shock-elicited aggression results obtained under similar deprivation states.

Pinel and Treit (1978) demonstrated that rat subjects administered a single electric shock via a stationary shock prod chose to bury the prod rather than attack, flee, or freeze as might have been predicted by Bolles' (1970) statement of species-specific defense reactions. Designated "defensive burying," this unusual behavior has subsequently been replicated in several laboratories (Davis, Whiteside, Dickson, Heck, & McKnab, in press; McKim & Lett, 1979; Oberdieck & Tarte, 1981). Following these demonstrations, the general trend of the burying research has been directed toward delineation of relevant parameters. For example, it has been shown that both albino and hooded rats (Davis, Whiteside, Heck, & Cowen, in press; Pinel, Treit, & Wilkie, 1980), as well as several strains of mice (Davis, Whiteside, Heck, Dickson, & Tramill, 1981; Treit, Terlecki, & Pinel, 1980), will engage in defensive burying. Also, it has been shown that the burying response is not elicited only by electric shock. A variety of stimuli, including the discharge of a flashbulb, a mouse trap, a tube that had delivered an airblast (Terlecki, Pinel, & Treit, 1979), and a tube that had delivered Tabasco sauce (Wilkie, MacLennan, & Pinel, 1979), have been shown to elicit burying. Beninger, MacLennan, and Pinel (1980) and Davis, Whiteside, Dickson, Thomas, and Heck (1981) have shown that the burying response may be influenced by selected drug states but that retention testing under the nondrug condition is not affected.

On the other hand, there exists a body of literature in the area of shock-elicited aggression that would seem to be related to defensive burying. The similarities between the two situations would appear to center upon the test subject's (1) being presented with an aversive stimulus in each situation and (2) being able to engage in some type of behavior following presentation of this stimulus. Given these similarities, it might be predicted that manipulations shown to influence shock-elicited aggression

responding would also affect the display of defensive burying. For example, a recent series of studies (Davis, Cronin, Meriwether, Neideffer, & Travis-Neideffer, 1978; Davis, Gussetto, Tramill, Neideffer, & Travis-Neideffer, 1978; Neideffer, Travis, Davis, Voorhees, & Prytula, 1977) has clearly demonstrated that insulin-induced hypoglycemia results in increased shock-elicited aggression. Further, Cahoon, Crosby, Dunn, Herrin, Hill, and McGinnis (1971) and Hamby and Cahoon (1971) have shown that rat subjects tested under food and water deprivation, respectively, displayed significantly higher levels of shock-elicited aggression responding than did satiated controls. Finally, Mollenhour, Voorhees, and Davis (1977) reported that the display of shock-elicited aggression was positively related to the duration of rapid eye movement (REM) sleep deprivation.

An initial attempt to ascertain the effects of variables such as those mentioned above in the defensive burying paradigm was reported by Davis and Rossheim (1980). In contrast to the previous shock-elicited aggression data, these investigators reported that insulin-induced hypoglycemia resulted in significantly lower defensive burying scores. In view of these data, the present study sought to determine what relationship, if any, exists between food or water deprivation and defensive burying.

METHOD

Subjects

Twenty-four male Holtzman rats served as subjects. The animals were approximately 90 days old at the beginning of experimental testing. Two weeks prior to testing, three equal-sized groups ($n = 8$) were randomly formed. In turn, these groups were randomly assigned to food-deprivation (FD), water-deprivation (WD), or nondeprived (ND) conditions. The subjects in Groups FD and WD were placed on deprivation at this time. Animals in Group FD were maintained at 85% of their free-feeding body weights, and subjects in Group WD were allowed access to water for 1 h each day. Subjects in Group ND were allowed free access to food and water at all times.

Apparatus

A rectangular enclosure (25 cm wide, 45 cm long, and 30 cm high), constructed of Plexiglas and glass, served as the

This research was supported, in part, by a grant from the Research and Creativity Committee of Emporia State University to the first author.

test chamber. A 4.00-cm layer of San-I-Cel animal bedding material (Paxton Processing Company, Paxton, Illinois) covered the entire floor. An opaque plastic collar (3.5 cm long x 3.0 cm in diameter) was mounted in the center of an end (Plexiglas) wall 1 cm above the bedding material. The aversive stimulus, an M-3 flashbulb, was mounted inside the collar with contact leads exiting via a 2.00-cm hole directly behind it.

Procedure

Two days prior to experimental testing, each subject received an individual 4-h habituation session to the bedding material. Habituation sessions took place in a rectangular enclosure, similar, except for the absence of an aversive stimulus device, to that used in actual test sessions.

A test session was conducted by placing the designated subject in the center of the test chamber, facing away from the aversive stimulus. When the subject came in close proximity to the plastic collar (nose approximately 1 cm from the collar), the flashbulb was discharged. Concurrent with the discharge of the flashbulb, a 15-min session timer was activated. The time spent engaged in defensive burying (movement of bedding material toward or over the aversive stimulus) was recorded during the 15-min test session by two independent observers using electronic timers. At the completion of each individual test session, the height of accumulated bedding material was recorded at three points: 1 cm to the left, in front of, and to the right of the aversive stimulus device. As the floor of the testing chamber was smoothed to a uniform 4.00-cm height prior to the testing of each subject, it was possible to calculate the exact height of bedding material accumulated at each of these locations. The order for running subjects was determined randomly.

RESULTS

As a high degree of agreement ($r = .92$) existed between the two observers regarding the amount of time each subject spent engaged in defensive burying, the two time scores for each animal were averaged to yield a single representative score. Similarly, the three height-of-accumulation scores were averaged to yield a single score for each subject. These average scores were used for analysis and graphing purposes. Group means reflecting time spent in defensive burying and the height of accumulated bedding material are shown in Figure 1. The impression created by Figure 1 would appear to be rather straightforward: Groups FD and WD did not

Figure 1. Mean time spent in defensive burying (left) and mean height of accumulated bedding material (right) for Groups FD, WD, and ND.

spend as much time engaged in defensive burying, nor did they accumulate as much bedding material around the aversive stimulus as did Group ND.

Statistical analyses corroborated this graphical picture. Analysis of variance yielded a significant groups effect for the duration of burying [$F(2,21) = 6.72$, $p < .01$] and height [$F(2,21) = 7.21$, $p < .01$] measures. The Newman-Keuls procedure was used to make specific group comparisons, and it indicated that in both cases Groups FD and WD did not differ significantly from each other, but they were significantly ($p < .01$) lower than Group ND.

DISCUSSION

These results, in conjunction with the previously mentioned hypoglycemia and defensive burying data (Davis & Rossheim, 1980), suggest that at least several of the manipulations shown to increase shock-elicited aggression responding actually result in a decrease in the defensive burying response. Certainly, discussion might well end at this point by simply calling attention to these two apparently disparate functional relationships. However, it would appear to be of some interest to offer commentary, albeit speculative, as to possible reasons for this difference. It may be that we are dealing with two different behaviors, that is, aggression vs. defensive responding. Unfortunately, a clear distinction between these two behaviors does not appear to have been made in the literature. In some cases, these labels may have even been used interchangeably. For example, Bolles (1970) considers attack to be a species-specific defense reaction, whereas Moyer (1968), in his categorization of aggressive behaviors, would appear to consider it as a form of "irritable aggression." On the other hand, Blanchard and Blanchard (1977) and Takahashi and Blanchard (1978) have indicated that shock-elicited aggression is not a good index of attack behavior but does reflect a defensive behavior pattern more adequately. As Pinel, Hoyer, and Terlecki (1980) have shown that both approach-avoidance responding (typically shown in defensive situations; see Blanchard & Blanchard, 1970a, 1970b) and burying behavior are shown to the same stimulus, it would appear that shock-elicited aggression and defensive burying might be better characterized as defensive behaviors, as opposed to attack or aggressive reactions. Despite this extrapolation, additional work is certainly needed to further clarify such distinctions.

If one cannot appeal to differences between behaviors to account for the discrepant data, then additional variables must be considered. Two possibilities involve the testing situations employed. First, several of the previously reported studies (e.g., Mollenhour et al., 1977; Neideffer et al., 1977) demonstrating a positive relationship between shock-elicited aggression and deprivation have employed the single-retrained-animal procedure developed by Azrin, Rubin, and Hutchinson (1968). Obviously, such a restraint procedure would be very difficult to implement and evaluate in the burying paradigm. On the other hand, multiple presentations of the aversive stimulus, typically electric shock, have been employed in shock-elicited aggression studies, whereas only one application of the aversive stimulus is more typical of defensive burying testing. At this point, one can only wonder what the effect of multiple aversive stimulus presentation would be in the defensive burying situation. Possibly, burying scores would be elevated. As is so often the case with research, some questions have been answered by the present research, but others have surfaced. Happily, some of the questions that have been raised are open to test.

REFERENCES

- AZRIN, N. H., RUBIN, H. B., & HUTCHINSON, R. R. Biting attack by rats in response to aversive shock. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 633-639.
- BENINGER, R. J., MACLENNAN, A. J., & PINEL, J. P. J. The use of conditioned defensive burying to test the effects of pimozide on associative learning. *Pharmacology, Biochemistry and Behavior*, 1980, 12, 445-448.
- BLANCHARD, R. J., & BLANCHARD, D. C. Dual mechanisms in passive avoidance: I. *Psychonomic Science*, 1970, 19, 1-2. (a)
- BLANCHARD, R. J., & BLANCHARD, D. C. Dual mechanisms in passive avoidance: II. *Psychonomic Science*, 1970, 19, 3-4. (b)
- BLANCHARD, R. J., & BLANCHARD, D. C. Aggressive behavior in the rat. *Behavioral Biology*, 1977, 21, 197-224.
- BOLLES, R. C. Species-specific defense reactions and avoidance learning. *Psychological Review*, 1970, 77, 23-48.
- CAHOON, D. D., CROSBY, R. M., DUNN, S., HERRIN, M. S., HILL, C. C., & MCGINNIS, M. The effect of food deprivation on shock elicited aggression in rats. *Psychonomic Science*, 1971, 22, 43-44.
- DAVIS, S. F., CRONIN, E. L., MERIWETHER, J. A., NEIDOFFER, J., & TRAVIS-NEIDOFFER, M. N. Shock-elicited attack and biting as a function of chronic vs. acute insulin injection. *Bulletin of the Psychonomic Society*, 1978, 12, 149-151.
- DAVIS, S. F., GUSSETTO, J. K., TRAMILL, J. L., NEIDOFFER, J., & TRAVIS-NEIDOFFER, M. N. The effects of extended insulin dosage on target-directed attack and biting elicited by tailshock. *Bulletin of the Psychonomic Society*, 1978, 12, 80-82.
- DAVIS, S. F., & ROSSHEIM, S. A. Defensive burying as a function of insulin-induced hypoglycemia and type of aversive stimulation. *Bulletin of the Psychonomic Society*, 1980, 16, 229-231.
- DAVIS, S. F., WHITESIDE, D. A., DICKSON, V. A., HECK, D. G., & MCKNAB, P. A. Conditioned defensive burying as a function of stimulus modality and stimulus accessibility. *Journal of General Psychology*, in press.
- DAVIS, S. F., WHITESIDE, D. A., DICKSON, V. A., THOMAS, R. L., & HECK, D. G. Conditioning and retention of defensive burying as a function of Elavil and Thorazine injection. *Bulletin of the Psychonomic Society*, 1981, 17, 107-110.
- DAVIS, S. F., WHITESIDE, D. A., HECK, D. G., & COWEN, C. L. Defensive burying as a function of single- and paired-animal testing conditions. *Journal of General Psychology*, in press.
- DAVIS, S. F., WHITESIDE, D. A., HECK, D. G., DICKSON, V. A., & TRAMILL, J. L. Defensive burying: A cross-species replication and extension. *Bulletin of the Psychonomic Society*, 1981, 17, 45-47.
- HAMBY, W. G., & CAHOON, D. D. The effect of water deprivation upon shock elicited aggression in the rat. *Psychonomic Science*, 1971, 25, 166-167.
- McKIM, W. A., & LETT, B. T. Spontaneous and shock-induced burying in two strains of rats. *Behavioral and Neural Biology*, 1979, 26, 76-80.
- MOLLENHOUR, M. N., VOORHEES, J. W., & DAVIS, S. F. Sleepy and hostile: The effects of REM sleep deprivation on shock-elicited aggression. *Animal Learning & Behavior*, 1977, 5, 148-152.
- MOYER, K. E. Kinds of aggression and their physiological basis. *Communications in Behavioral Biology*, 1968, 2, 65-87.
- NEIDOFFER, J., TRAVIS, M. N., DAVIS, S. F., VOORHEES, J. W., & PRYTULA, R. E. Sweet and sour rats: The effect of insulin dosage on shock-elicited aggression. *Bulletin of the Psychonomic Society*, 1977, 10, 311-312.
- OBERDIECK, F., & TARTE, R. D. The effect of shock prod preexposure on conditioned defensive burying in rats. *Bulletin of the Psychonomic Society*, 1981, 17, 111-112.
- PINEL, J. P. J., HOYER, E., & TERLECKI, L. J. Defensive burying and approach-avoidance behavior in the rat. *Bulletin of the Psychonomic Society*, 1980, 16, 349-352.
- PINEL, J. P. J., & TREIT, D. Burying as a defensive response in rats. *Journal of Comparative and Physiological Psychology*, 1978, 92, 708-712.
- PINEL, J. P. J., TREIT, D., & WILKIE, D. M. Stimulus control of defensive burying in the rat. *Learning and Motivation*, 1980, 11, 150-163.
- TAKAHASHI, L. K., & BLANCHARD, R. J. Shock and defensive fighting in the rat. *Bulletin of the Psychonomic Society*, 1978, 12, 211-213.
- TERLECKI, L. J., PINEL, J. P. J., & TREIT, D. Conditioned and unconditioned defensive burying in the rat. *Learning and Motivation*, 1979, 10, 337-350.
- TREIT, D., TERLECKI, L. J., & PINEL, J. P. J. Conditioned defensive burying: Organismic variables. *Bulletin of the Psychonomic Society*, 1980, 16, 451-454.
- WILKIE, D. M., MACLENNAN, A. J., & PINEL, J. P. J. Rat defensive behavior: Burying noxious food. *Journal of the Experimental Analysis of Behavior*, 1979, 31, 299-306.

(Received for publication October 1, 1981.)