Pressurized air: The negative factor¹

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Normal and impaired-hearing rats were trained with a light CS in a pressurized-air shuttle-avoidance task. No differences were observed between these two groups in emotionality, number of escapes, percent learning, trials to criterion, number of avoidances and escape response latency. Results were interpreted as indicating that the tactual experience of air blast rather than the auditory experience is the primary negative quality of this US.

The effectiveness of pressurized air as a US in shuttle avoidance has been demonstrated with cats (Ray, 1965), rats (Ray, 1966a), and monkeys (Polidora & Boyer, 1967). All three species learn rapidly and with relatively little emotion.

What quality of pressurized air enables it to sustain avoidance responding? In monkeys at least, the auditory experience of the very high pressure used by Polidora and Boyer (100 psi) was a negative one, and they did escape the air blast noise only. However, the monkeys gradually ceased to do this and, in later sessions, they did not shuttle upon hearing the blast. Experience with cats indicated that approximately 25 psi working load was necessary to motivate them to shuttle. Twenty psi, though it sounded much the same, did not reliably cause cats to go from one room to the other (Ray, 1965). Pilot work with rats resulted in similar findings—even to what seemed to be the minimum effective pressure, 25 psi. To determine the extent to which pressurized air with a minimal auditory component was still aversive, the following experiment was performed.

Subjects

Ss were 23 female Sprague-Dawley rats between 100 and 110 days old. They were housed in six community cages and were maintained on an ad lib diet of Purina lab chow and water.

Procedure

Three groups were randomly constituted: an impaired auditory group (Group I, $N=10$), a hearing group (Group H, $N=10$), and a chloroform control group (Group C, $N=3$). The 20 rats from Groups I and H (randomly arranged) were administered the following serial treatments:

(a) On the day before training a rat was lightly anesthetized with chloroform.

(b) If in Group I, the auditory threshold of each rat was elevated by piercing the tympanic membrane and disrupting the bones of the middle ear with a blunt probe. The procedure (which requires about 1 min) reduces auditory sensitivity 40–45 dB. The rat was then returned to its home cage. If in Group H, the rat was anesthetized and handled as above, but the ear drums were not pierced.

(c) On the day following the above treatments the rat was introduced into the shuttle avoidance apparatus. Training procedures were as have been previously described (Ray, 1966a, c) with the exception that the CS in this experiment was a light, not a light-buzzer combination. The following training parameters obtained: a 28 V, instrument panel light CS; and 8 sec CS-US interval; 25 psi air pressure US; and a 2 min intertrial interval. All sessions commenced with the ITI. Rats were trained either to a criterion of five consecutive avoidance responses or until 40 trials had been completed, whichever came first. Training continued for no more than three days at the rate of 16 trials on Day 1 and 12 trials each on Days 2 and 3.

(d) Following completion of training, rats in Group I were sacrificed and disruption of the tympanic membrane and ossicles anatomically verified. Group C Ss received no chloroform anesthesia and provided a baseline comparison for Group H.

The following data were recorded and subsequently analyzed in all groups: (1) emotionality—as indicated by the number of boli and instances of urination; (2) the number of escape responses; (3) the percent learning; (4) trials to criterion performance, (5) the number of avoidance responses; and (6) response latency.

Results

Prior to analysis of the experimental group data, the two control groups (Groups C and H) were compared on all dependent variables and, where necessary, tests of significance were performed to determine whether any observed differences were significant. None were, indicating that brief exposure to chloroform has no significant behavioral effect in shuttle avoidance in the rat. The Group C data were not subsequently pooled with Group H data but are presented independently for comparison. All dependent variables appear in Table 1.

Group H rats did not defecate and urinate more than Group I rats ($p>0.8$, Kolmogorov-Smirnov test) indicating that, in terms of emotional arousal, both groups responded similarly to the US.

Group H rats did not escape the air blast any more often than Group I rats ($X^2=0.2$, $p>.7$), nor did they avoid more often ($X^2=0.2$, $p>.7$); mobility in the two groups was nearly identical.

Neither group could be distinguished on the basis of the percentage of Ss attaining criterion (30% in each condition), or by the rate at which criterion performance was achieved (trials to criterion, $p>.8$, Kolmogorov-Smirnov test).

Inasmuch as both groups had nearly the same number

Table 1
Summary of performance by rats in
pressurized-air shuttle responding to light CS

Dependent Variable	Group		
	I	H	CC
	mean (sigma) n = 10	mean (sigma) n = 10	mean (sigma) n = 3
Emotionality (Boluses and urinations)	4.6 (3.3)	4.7 (2.6)	5.7 (1.9)
Number of escapes (All Ss)	29.0 (13.0)	30.7 (9.9)	34.0 (8.5)
Per cent learning	30	30	33 1/3
Trials to criterion	31.6 (13.2)	34.3 (10.0)	34.0 (8.5)
Number of avoidances	4.1 (3.2)	5.1 (4.4)	4.7 (5.9)
Escape response latency (Random samples from groups I and A)	8.9 (1.7)	8.4 (1.2)	----

of escape responses (about 300) it was possible to take a random sample of escape response latencies from each group (60 in Group H, 58 in Group I) and to compare these sample distributions. There was no significant difference in the mean latency of either sample ($t=0.187$, $df=118$, $p>.8$); rats in either group escaped the air blast at the same speed.

Discussion

Conductive hearing deficits do not completely impair hearing (Davis, 1951). However, it is widely agreed that a decrement of approximately 40 dB to 45 dB results when the ear drum and bones of the middle ear are well disrupted (Turner, 1924). Pressurized air released at 25 psi through the small holes of a shower nozzle generates a hissing sound of about 95 dB, 3 in. from the nozzle. Assuming the conductive loss to be 40 dB, the auditory component of the air blast is reduced to an approximate maximum of 55 dB. This sound level is 20 to 30 dB lower than auditory CSs used by nearly all researchers, and it would be difficult to argue that any sound at this low intensity is, of itself, aversive.

Although the lack of any difference between the two groups is consistent through all the dependent variables, emotionality and escape response latency data provide the strongest evidence that the tactile component of pressurized air is the primary negative experience. Had the auditory component been negative, it should have been reflected by an increased level of emotionality, increased fearfulness, in the normally hearing rats. Moreover, had the auditory experience contributed significantly to emotional arousal, the latency of escape responding would have shown this

differentially; the "deaf" rats should have responded to the US less rapidly than the hearing rats. The data clearly show that responding by the impaired rats is fully as rapid as that by the hearing rats—both groups escape almost immediately after the US is presented.

That Polidora and Boyer observed any shuttle responding by monkeys to their 100 psi air blast sound can be readily understood by considering the intensity of that US. Such a US must be extremely loud. Masserman & Pechtel (1953) used less than 12 psi with their monkeys and found this pressure adequate to produce passive avoidance.

The basis for the aversiveness of electric shock is obvious—it is painful. The same may not be said of pressurized air. Air blast is not painful to rats, cats, or squirrel monkeys. Masserman, following incidental experimentation, concluded that cats were genetically averse to pressurized air and that the auditory component was probably not important (1943). Pressurized air seems to be disliked rather than feared. The basis for its negative quality appears to be tactual: Rats respond negatively to the *feel* of air blast rather than to its sound. Piloerection caused by the air coursing over the animals' backs may be the actual aversive experience.

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Notes

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