Bulletin of the Psychonomic Society
1991, 29 (3), 237-239

Diminished ingestive behavior of Fischer 344 rats following treatment with polyethylene glycol

P. J. WATSON and BETTY J. PLANK
University of Tennessee at Chattanooga, Chattanooga, Tennessee

Fluid and food intakes of Fischer 344 and Sprague-Dawley rats were compared in the 24 h after treatment with polyethylene glycol (PEG), and subjects were presented with drinking supplies of physiological saline or tap water. As in previous investigations, Fischer rats displayed relatively lower levels of ingestive behavior, a pattern that remained evident even in the longer post-PEG interval when animals drank copious amounts of the saline solution. These data therefore confirmed again that Fischer rats are more "economical" in their behavioral responsiveness, and that strain differences may exert noteworthy influences on research into the physiological controls of ingestive behavior.

Complexities in the physiological controls of feeding and drinking have been uncovered in recent research on the ingestive behavior of different strains of rats. The Fischer 344 strain, in particular, has offered numerous contrasts (Rowland & Fregly, 1988c). For example, these animals drink little water in the absence of dry food, fail to display the typical preference for NaCl solutions, exhibit lower levels of spontaneous drinking and lowered fluid/food ratios, eat less food daily, respond to sodium depletion with diminished though physiologically adequate amounts of salt intake, and consume less fluid after isoproteronol and after polyethylene glycol (Midkiff, Fitts, Simpson, & Bernstein, 1985; Rowland & Fregly, 1988a, 1988b; Walsh, 1980). Such differences suggest the importance of ecological variables in determining consummatory activity (Rowland, 1977) and indicate that Fischer rats may be characterized by "a more general behavioral economy" (Rowland & Fregly, 1988c, p. 466).

In the present project, the responsivity of Fischer rats to polyethylene glycol (PEG) was reexamined. PEG produces hypovolemia by removing both water and sodium from the body; and the ingestion of hypotonic solutions does not alleviate the deficit triggered by this stimulus. Indeed, water consumption inhibits further drinking, perhaps by diminishing the effective osmotic pressure in body fluids and by promoting cellular overhydration (Stricker, 1971). Saline solutions are more responsive to the PEG-induced need state (see, e.g., Tordoff, Hopfenbeck, & Novin, 1982), and Rowland and Fregly (1988a) found that Fischer rats drank substantial amounts of saline solution but not of water in the first 6 h after PEG. The consumption of the Fischer strain was nevertheless lower than that displayed by Sprague-Dawleys.

Completion of this project was made possible in part through funds obtained from the University of Chattanooga Foundation. All correspondence should be addressed to P. J. Watson, Psychology Department, 350 Holt Hall, 615 McCallie, University of Tennessee at Chattanooga, Chattanooga, TN 37403.

Three concerns supported the present reexamination of PEG. First, post-PEG drinking was analyzed more systematically than in the earlier work. In a factorial design, Fischer and Sprague-Dawley intakes of water and physiological saline were determined after PEG and control injections. Second, some evidence suggests that rats of the same strain but obtained from different suppliers can vary in their reactivity to regulatory challenges (see Fregly, Paulding, & Rowland, 1990, p. 1192); and the subjects in the present study were obtained from a supplier not examined previously. Finally, and most importantly, the saline solution consumption of Fischer rats was determined in the longer term after PEG. Rats drink copious amounts of saline solution during the 24 h after PEG (see, e.g., Stricker, 1971; Watson & Swartwood, 1990); and these longer term intakes seemed to offer a particularly robust test of the claim that the Fischer strain is more "economical" in its behavioral responsiveness.

METHOD

Subjects

Fischer 344 and Sprague-Dawley rats of approximately the same age were purchased from Taconic Farms (Germantown, NY). These 40 animals, 20 from each strain, were adapted to the laboratory over a span of several months prior to the beginning of the study. At the beginning of the experimental trials, the Fischer rats weighed 335.4 ± 3.0 g ($M \pm SE$), while the Sprague-Dawleys averaged 452.0 ± 6.6 g. Such weight differentials further revealed the lowered Fischer consummatory activity and have been noted previously (see, e.g., Rowland & Fregly, 1988c).

Procedure

All rats were housed in 7 × 7 × 9.5 in. stainless steel cages in a room in which the ambient temperature was controlled thermostatically at 72° F. Purina Lab Chow and tap water were made available ad lib, and lights were turned on at 0800 h and turned off at 2000 h.

In a random fashion, half of the subjects from both strains were assigned either to the water or to the saline fluid condition. Collection of the experimental data was preceded by 3 days of familiarization trials in which all animals received injections of physiological saline made subcutaneously in the back. These adaptation procedures were conducted at approximately 1030 h.

At the same time on the day after the last familiarization trial, half of the rats in each fluid condition received 30% w/v PEG, 10 cc/kg body weight; and the other half of each fluid condition received control physiological saline injections. All subjects were placed back into their home cages, where the appropriate drinking supply, either physiological saline or water, was made available. Fluid intakes in the absence of food were monitored during the first 4 h after these injections; intakes of both fluid and Purina Lab Chow pellets were then recorded for the next 20 h. Care was taken to collect all spillage of food through the cage floor. One week later, these procedures were repeated, but with the injection conditions reversed.

All data were analyzed with a 2×2×2 analysis of variance (ANOVA), with the strain and fluid conditions operating as between-subjects variables and with the injections serving as a within-subjects factor.

RESULTS

The obtained data are summarized in Table 1. In the 4 h immediately after injections, the Fischer rats drank less than the Sprague-Dawleys [$F(1,36) = 13.89$, $p < .001$], saline intakes were generally higher than those for water [$F(1,36) = 5.59, p < .025$], and the saline enhancement of drinking appeared in Sprague-Dawleys but not in the Fischer subjects [strain × fluid interaction, $F(1,36) = 6.95$, $p < .025$]. PEG increased fluid consumption generally [$F(1,36) = 9.13, p < .005$], and this effect was more obvious when the saline solution was made available [injection × fluid interaction, $F(1,36) = 4.31$, $p < .05$]. The injection × strain interaction further revealed that Fischer rats were less responsive to PEG [$F(1,36) = 4.71$, $p < .05$].

In the next 20 h, Fischer rats still drank relatively less [$F(1,36) = 66.06$, $p < .001$]; and saline consumption again exceeded that of water [$F(1,36) = 48.72$, $p < .001$]. PEG also continued to promote higher fluid intakes overall [$F(1,36) = 70.25, p < .001$]. The strain × fluid interaction [$F(1,36) = 13.17, p < .001$] demonstrated that Fischer subjects were less responsive to saline; and the three-way interaction [$F(1,36) = 7.56$, $p < .01$] more particularly indicated that the Fischer rats consumed more saline only during the PEG condition, whereas the Sprague-Dawleys drank more after both injections. The fluid × injection interaction [$F(1,36) = 50.69$, $p < .001$] again revealed a minimal change in water intake but a greatly enhanced consumption of saline after PEG.

Fischer rats also ate less in the longer posttreatment interval [$F(1,36) = 18.55, p < .001$]; and PEG produced a general reduction in feeding behavior [$F(1,36) = 106.45$, $p < .01$]. More food on average was ingested when saline was made available [$F(1,36) = 8.32$, $p < .01$]; and the fluid × injection interaction [$F(1,36) = 16.18, p < .001$] suggested that the latter effect was attributable largely to the ability of saline to ameliorate the PEG-induced decline.

Fluid/food ratios also were computed, and saline intakes after PEG were positively skewed because 2 Fischer and 2 Sprague-Dawley animals drank large volumes of fluid while consuming little food. A logarithmic transform was utilized to address this difficulty (Myers, 1972), and an analysis of these data demonstrated that Fischer rats had lower ratios [$F(1,36) = 6.80, p < .025$] but that PEG increased them [$F(1,36) = 75.33, p < .001$]. No other main effect or interaction proved to be statistically significant in this or in any other ANOVA.

DISCUSSION

Results from the present investigation replicate and extend previous findings. Fischer rats once again drank less in response to the hypovolemia produced by PEG, and demonstration of this effect was accomplished in an experimental design that systematically manipulated both the injection and the drinking fluid conditions. Indeed, in the first 4 h, Fischer rats consumed less water after PEG than they did after the control injections. Sprague-Dawley intakes, on the other hand, were higher after PEG regardless of which fluid was available.

Especially noteworthy was the continued contrast between Fischer and Sprague-Dawley subjects in the longer term after PEG. Previous research had documented that the combination of PEG injections plus access to saline solutions produces a particularly high level of fluid intake (e.g., Striker, 1971); and in the present study, the Sprague-Dawley group in fact consumed close to 100 ml during the later 20-h period. Fischer subjects drank about half that amount. In short, the Fischer animals again exhibited their more conservative behavioral responsiveness even in the presence of unusually potent dipsogenic factors. Ob-

Table 1
Ingestive Behavior (Means ± Standard Errors) of Fischer 344 (F-344), and Sprague-Dawley (S-D) Rats after Polyethylene Glycol (PEG) or Control (CON) Injections

		Water				Saline Solution			
		PEG		CON		PEG		CON	
Measure	Rat Strain	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
4-h fluid	F-344	2.9	0.36	3.1	0.46	3.3	0.60	2.3	0.28
	S-D	4.2	0.69	3.0	0.53	8.5	1.41	4.2	0.82
20-h fluid	F-344	29.8	1.65	25.3	0.92	50.3	3.27	26.4	2.62
	S-D	42.6	3.57	41.5	2.68	98.7	5.65	53.8	6.03
20-h food	F-344	9.3	1.52	20.8	0.69	13.3	1.13	19.0	0.96
	S-D	11.5	1.97	23.4	1.10	19.9	0.75	24.2	1.00
20-h fluid/food	F-344	0.64	0.13	0.08	0.01	0.60	0.02	0.12	0.04
	S-D	0.73	0.13	0.25	0.04	0.69	0.03	0.32	0.05

Note—Fluid intake amounts are expressed in milliliters, and food consumption is presented in grams. Fluid/food ratios were converted into logarithims in order to correct for the positive skew of these data.

servations that Fischer rats generally ate and drank less regardless of the injection condition further confirmed the diminished consummatory activity of this strain.

The strain × fluid × injection interaction was significant when the 20-h fluid intakes were examined, and this outcome occurred when saline otherwise failed to facilitate Fischer rat drinking. These data thus indicated that although Fischer rats did not equal the Sprague–Dawley intakes of saline, they nevertheless remained responsive to the internal need state produced by PEG. Hence, as Rowland and Fregly (1988b, 1988c) make clear, the reduced consumption of Fischer rats apparently does not represent a deficit. Some strains that are bred for research purposes may have biological control systems that are less closely tied to the selection pressures of the natural environment. As a consequence, these animals may consume in excess of the most basic physiological requirements.

In summary, Fischer rats obtained from a different supplier again displayed "a more general behavioral economy," a conclusion further supported by their significantly lower fluid/food ratios. As in previous work, therefore, the present data suggest that researchers who attempt to understand the physiological controls of ingestive behavior may need to determine how strain differences contribute to experimental outcomes.

REFERENCES

FREGLY, M. J., PAULDING, W., & ROWLAND, N. E. (1990). Comparison of the dipsogenic responsiveness of Long-Evans and Sprague-Dawley rats. *Physiology & Behavior*, **47**, 1187-1192.

MIDKIFF, E. E., FITTS, D. A., SIMPSON, J. B., & BERNSTEIN, I. L. (1985). Absence of sodium chloride preferences in Fischer 344 rats. *American Journal of Physiology*, **252**, R562-R566.

MYERS, J. L. (1972). *Fundamentals of experimental design*. Boston: Allyn & Bacon.

ROWLAND, N. E. (1977). Regulatory drinking: Do the physiological substrates have an ecological niche? *Biobehavioral Review*, **1**, 261-272.

ROWLAND, N. E., & FREGLY, M. J. (1988a). Behavioral and physiological aspects of body fluid homeostasis in Fischer 344 rats. *Physiology & Behavior*, **42**, 499-505.

ROWLAND, N. E., & FREGLY, M. J. (1988b). Induction of an appetite for sodium in rats that show no spontaneous preference for sodium chloride solution—the Fischer 344 strain. *Behavioral Neuroscience*, **102**, 961-968.

ROWLAND, N. E., & FREGLY, M. J. (1988c). Regulation of intakes of water and NaCl solutions in Fischer 344 rats: Contrasts and comparisons between strains. *Physiology & Behavior*, **44**, 461-467.

STRICKER, E. M. (1971). Inhibition of thirst in rats following hypovolemia and/or caval ligation. *Physiology & Behavior*, **6**, 293-298.

TORDOFF, M. G., HOPFENBECK, J., & NOVIN, D. (1982). Hepatic vagotomy (partial hepatic vagotomy denervation) does not alter ingestive responses to metabolic challenges. *Physiology & Behavior*, **28**, 417-424.

WALSH, L. L. (1980). Differences in food, water, and food-deprivation water intake in 16 strains of rats. *Journal of Comparative & Physiological Psychology*, **94**, 775-781.

WATSON, P. J., & SWARTWOOD, J. N. (1990). Responsivity to water regulatory challenges in rats adapted to fluids adulterated with quinine or citric acid. *Physiology & Behavior*, **47**, 789-793.

(Manuscript received December 5, 1990.)