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Prolactin and Growth Hormone Stimulate Food Intake in Ring Doves

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BUNTIN, J. D. AND G. R. FIGGE. *Prolactin and growth hormone stimulate food intake in ring doves.* PHARMACOL BIOCHEM BEHAV **31**(3) 533–540, 1988.—Ingestive behavior and body weight were measured in male and female ring doves given twice daily subcutaneous injections of ovine prolactin (7 mg/kg/day) or vehicle and in male doves given daily intracerebroventricular (ICV) injections of ovine prolactin at doses ranging from 0.1 to 2.0 μg/day. Changes induced by ICV administration of turkey prolactin, turkey growth hormone, ovine growth hormone, human growth hormone, and vehicle were also examined. Subcutaneous injections of ovine prolactin markedly increased food intake and body weight in both sexes. Similar effects occurred in dose-related fashion in male doves given ICV injections of ovine prolactin. The three growth hormone preparations also increased feeding and body weight significantly, but turkey prolactin was ineffective in this regard. Changes in drinking generally paralleled feeding patterns but were less pronounced and may have been secondary to feeding changes. We conclude that feeding in this species is strongly stimulated by some prolactin and growth hormone preparations. However, the physiological mechanisms underlying these effects remain to be clarified.

Feeding Drinking Prolactin Growth hormone Dove

PROLACTIN (PRL) is a pituitary hormone and putative neuropeptide (19, 24, 58) with diverse physiological and behavioral actions (4, 14, 47). Prolactin reportedly promotes hyperphagia in several vertebrate species, and some investigators have suggested a causal role for the hormone in the elevated food intake associated with mammalian lactation (35,42) and premigratory fattening responses in passerine birds (21). However, the effects of PRL on food intake have not been systematically characterized in any species and the available data suggest that the effects of the hormone on ingestive behavior may be complex. In rats, the effects of PRL vary markedly with sex, physiological state, and experimental conditions. Increased food intake has been reported in virgin female rats made hyperprolactinemic by ectopic pituitary transplantation (42) and in virgin females given systemic injections of ovine PRL (35). Exogenous PRL administration also reportedly increased food intake in hypophysectomized, ovariectomized females but had diminished effectiveness in males (51), and had little effect in lactating females whose pups had been removed (22) and in ovariectomized virgin females with intact putuitaries (23).

Inconsistent effects of PRL on food consumption have also been reported in lower vertebrates. Hyperphagic effects of ovine or bovine PRL have been reported in toads (63), in two lizard species (36,37) and in hypophysectomized pigeons following systemic injections of mammalian PRL preparations (2,54). Food intake is also dramatically increased in ring doves following intracerebroventricular injections of ovine PRL (9). In contrast, no increase was observed in spotted munia given intramuscular injections of bovine PRL (12) and a significant decrease in food consumption was recorded in turkey hens given intracerebral injections of a purified turkey PRL preparation (16).

These conflicting patterns of PRL-induced changes in food intake may reflect species differences in sensitivity to various PRL preparations or the confounding influence of other physiological factors which may mediate or modulate the effects of PRL under different physiological conditions. Such possibilities cannot be adequately evaluated without additional information on the sites, characteristics, and mechanisms of PRL action in this regard. The ring dove is a good choice for investigating the effects of PRL on ingestive behavior because it is one of the few species in which feeding changes have been documented following central administration of the hormone. Effects of PRL on food intake in this species are also dramatic, with males and females exhibiting an increase of 50–100% in daily food consumption and a 10–20% increase in body weight after 10 days of twice daily intracerebroventricular (ICV) injections of ovine PRL (9). Based on this previous work, the purpose of the present study was to characterize the dose-response relationship between centrally administered ovine PRL and changes in ingestive behavior in the ring dove and to compare these responses with those obtained following central administration of various preparations of growth hormone, a structurally related molecule with reputed hyperphagic actions of its own (2, 37, 51, 63). The effects of purified turkey PRL were also examined in an attempt to explain the opposing patterns of

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feeding changes induced in turkey hens by ICV injections of turkey PRL (16) and those induced in ring doves by ICV administration of ovine PRL (9). Male doves were used exclusively for these comparisons because previous work has shown that ovine PRL exerts more pronounced effects on food intake in this sex (9). Two additional objectives of the study were to determine whether systemic injections of ovine PRL were capable of altering food and water consumption in a manner similar to that observed following central administration of the hormone, and to determine if the sex-specific pattern of food intake changes seen in birds receiving ICV injections of PRL (9) is unique to this route of hormone administration.

METHOD

Animals

Eighty-seven adult male and 12 adult female ring doves were drawn from the colony maintained and bred at the University of Wisconsin-Milwaukee. Birds were housed in visual isolation from other birds for at least three weeks prior to the start of the experiment. Isolation cages were constructed of wood with wire mesh front doors and measured 40×40×53 cm. Constant photoperiod (14 hr light:10 hr dark; lights on at 0700 hr) and temperature conditions (20–22°C) were maintained and grit, water and seed mixture (kafir, milo, wheat, hulled oats, buckwheat, and white proso millet) were available at all times.

Procedure

Twelve male doves ranging in weight from 130.4 to 167.7 g (mean±SEM = 148.1±3.0 g) and 12 females ranging in weight from 135.6 to 161.3 g (mean±SEM = 146.3±2.0 g) were given twice-daily subcutaneous injections of ovine prolactin (oPRL; NIADDK oPRL-18, 7 mg/kg body weight, 30 IU/mg) or saline-$NaHCO_3$ vehicle (n=6 males and 6 females per group) for six consecutive days. Injections were given between 0700 and 0800 hr and between 1530 and 1700 hr. Food intake, water intake, and body weight were recorded once daily at 0700 hr beginning two days before the first injection. Changes in the weight of food and water containers were used to estimate daily intake. Containers were replenished with fresh seed mixture and water as needed.

The remaining 75 male doves were fitted with cannula assemblies which were stereotaxically implanted into the right lateral cerebral ventricle and secured to the skull with cranioplastic cement. Birds were allowed a minimum of 10 days to recover from the surgery prior to experimental use. Following the recovery period, food and water containers were weighed and body weights were recorded once daily at 1400 hr for five consecutive days to provide preinjection baseline data. Preinjection body weights of these animals ranged from 127.4 to 180.4 g and averaged 152.5±1.24 g (mean±SEM). Immediately following the last of these preinjection measurements, birds were randomly assigned to nine treatment groups and given daily ICV injections of one of the following: 0.1 μg oPRL (NIADDK oPRL-17, 34 IU/mg), 0.5 μg oPRL, 1.0 μg oPRL, 2.0 μg oPRL, 1.0 μg ovine growth hormone (oGH; NIADDK oGH-12), 1.0 μg human growth hormone (hGH; NIADDK hGH-I-1), 1.0 μg turkey prolactin (tPRL; purified and supplied by J. Proudman, USDA), 1.0 μg turkey growth hormone (tGH; purified and supplied by J. Proudman, USDA) or saline-$NaHCO_3$ vehicle. All treatment groups consisted of 8 birds each with the exception of the 1.0 μg oPRL group (n=12) and the oGH group (n=7). All injections were administered once daily at 1500–1600 hr for 5 consecutive days. Food and water containers were weighed and body weight was recorded immediately prior to each daily ICV injection (at approximately 1400 hr) and at 24 hr after the last injection.

After the last food, water and body weight measurement, blood samples (400–600 μl) were collected from each bird by wing vein venepuncture for radioimmunossay of plasma luteinizing hormone levels [see (7)]. Birds were then killed by anesthesia overdose on the day following blood collection for verification of cannula placement. Because changes in crop sac weight are a reasonably sensitive index of prolactin stimulation [see (47)], crop sacs were also removed and weighed at autopsy in order to evaluate the possibility that circulating PRL levels increased in response to ICV injections of the hormone.

Cannulation and Intracerebroventricular Injection

A double-barreled cannula assembly (Plastic Products, Inc., Roanoke, VA) was stereotaxically implanted into the right lateral cerebral ventricle of each bird in the ICV study and cemented to the skull under Chloropent anesthesia (Fort Dodge Laboratories, 3.0 ml/kg) using a modification (9) of the Gibson and Cheng (25) procedure. Each cannula assembly consisted of a 22 ga stainless steel outer guide cannula and a 28 ga inner dummy cannula. Intracerebroventricular injections were administered over a 15 sec period through a 10 μl Hamilton syringe which was attached via polyethylene tubing to a 28 ga infusion cannula (Plastic Products, Inc.). All hormones were injected in 2 μl sterile vehicle consisting of avian saline (0.87%) and 0.01 M $NaHCO_3$ (pH 8.0) in a ratio of 9:1. The injection cannula was removed and replaced with the dummy cannula at 1.5 to 2 min after injection.

At the end of the experiment, each bird in the ICV study received a 2 μl ICV injection of 25% India ink followed 5 min later by a lethal dose of Chloropent anesthesia (1 ml/bird). The subject was then perfused transcardially with avian saline (0.87%) followed by formalin (10%). The fixed brain was removed from the cranium and sectioned coronally for gross observation. Two birds were excluded from the experiment at this point because no dye was observed in the cerebral ventricular system. The crop sac and testes of each bird were also removed and weighed at autopsy.

Statistical Analysis

A two-tailed significance level of $p<0.05$ was used for all statistical analyses. In both the systemic injection study and the ICV injection study, repeated measures analyses of variance were used to analyze changes in food and water intake during the treatment period (BMPD Program 4V, Los Angeles, CA). Daily food and water consumption measurements during the pretreatment period in each study were averaged for each animal, and group differences were assessed using one-way analyses of variance. If a significant overall group difference was obtained in baseline food or water intake, then the relative change in intake was determined for each bird by expressing the average intake during the treatment period as a percentage of the baseline value for each subject. These percentage values were then used to test for treatment group differences using one-way analyses of variance and Tukey's studentized range tests. One-way analyses of variance were also used to assess differences across groups in pretreatment body weight (i.e., body weight on the day prior to treatment) and percent change in body

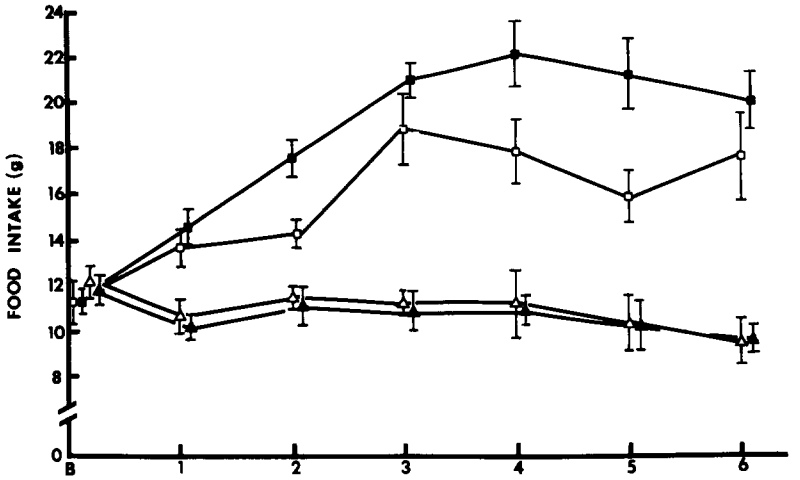

FIG. 1. Effects of twice daily subcutaneous injections of ovine prolactin (■□) or vehicle (▲△) on average daily food intake (mean±SEM) in male (■▲) and female (□△) ring doves (n=6/group) during a 6 day treatment period. Pretreatment (baseline) food intake values (B) are also indicated. See text for dosages. A significant treatment effect ($p<0.01$), sex × treatment interaction ($p<0.05$), and treatment × days interaction ($p<0.001$) were obtained.

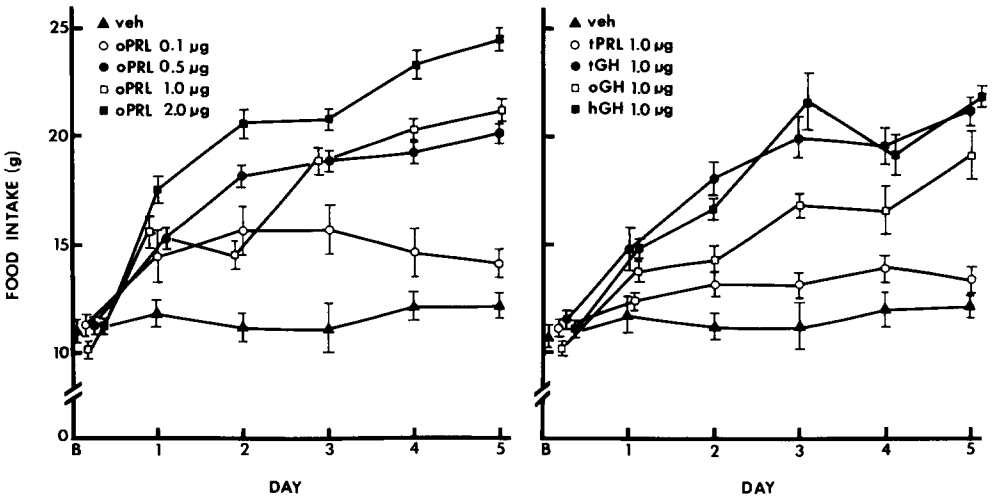

FIG. 2. Changes in food intake (mean±SEM) in male doves given daily intracerebroventricular injections of saline vehicle (veh) of purified prolactin (PRL) or growth hormone (GH) preparations of ovine (o), turkey (t), or human (h) origin. Doses shown are daily doses per bird. Baseline food intake levels (B) differed significantly across treatment groups ($p<0.05$) and a group × time interaction was observed ($p<0.001$) during the injection period. See text for details (n=8 for all treatment groups except 1.0 µg oPRL, n=10).

weight over the treatment period (i.e., body weight on day 5 of the treatment period) expressed as a percentage of pretreatment body weight.

If significant heterogeneity of variance was encountered across treatment groups on any measure, nonparametric Kruskal-Wallis one-way analyses of variance and Mann-Whitney U-tests (56) were employed in the analysis of overall treatment effects and pairwise group differences, respectively.

Missing data caused by occasional spilling of water containers during weighing resulted in a reduction in sample size in some water intake comparisons.

RESULTS

Systemic Injection Study

While no significant sex or gorup differences in food intake were observed prior to treatment (Fig. 1), PRL-injected birds ate approximately 70% more during the treatment period than did vehicle-injected controls, $F(1,20)=100.69$, $p<0.001$. Although a significant treatment difference was detectable in both sexes [males: $F(1,20)=76.37$, $p<0.001$; females: $F(1,20)=29.72$, $p<0.001$], the response to PRL injections was markedly sex-specific with PRL-injected males consuming significantly more food during the treatment

TABLE 1

EFFECTS OF SYSTEMIC INJECTIONS OF OVINE PROLACTIN OR VEHICLE ON WATER INTAKE AND BODY WEIGHT IN DOVES

Treatment Group	Sex	N	Daily Water Intake (g)	Body Weight (% change)
Vehicle	Male	6	13.87 ± 3.07	−1.0 ± 0.7
	Female	5	16.87 ± 2.54	−0.3 ± 0.9
Prolactin	Male	6	19.14 ± 3.05	+16.0 ± 1.1*
	Female	6	17.76 ± 4.85	+11.1 ± 1.5*†

Birds were given 6 twice-daily subcutaneous injections of ovine prolactin or saline vehicle (see text for dosage). Water intake values reflect average daily consumption (mean ± SEM) during the treatment period. Baseline water intake values did not differ significantly across sex or treatment groups. Body weights recorded at the end of the treatment period were compared with baseline values recorded during the two days period to injection to yield the percentage values for each subject. Values depicted are group means ± SEM. Significant differences were as follows: *$p<0.001$ vs. vehicle; †$p<0.005$ vs. male prolactin.

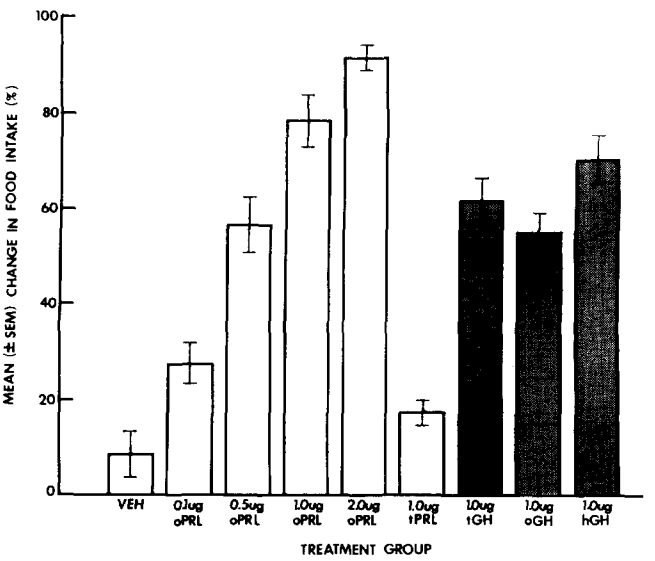

FIG. 3. Average % change in daily food intake (mean±SEM) in male doves given 5 daily intracerebroventricular injections of prolactin growth hormone, or saline vehicle. See Fig. 2 for abbreviations. Daily food intake values for the 5 treatment days were averaged and compared with the average baseline value for the 5 days prior to treatment to yield percentage values for each subject (n=8 per group except 1.0 μg oPRL, n=10). All groups except tPRL and 0.1 μg oPRL differed significantly from the vehicle control group ($p<0.01$).

period than PRL-injected females, $F(1,20)=9.20$, $p<0.01$. In contrast, no sex difference in feeding was observed in the vehicle-injected control group, thereby yielding a significant sex by group interaction effect, $F(1,20)=5.40$, $p<0.05$. Analysis of food intake patterns over time revealed that males and females in the PRL group exhibited a significant increase in daily food consumption during the treatment period [males: $F(5,100)=11.70$, $p<0.001$; females: $F(5,100)=6.32$, $p<0.001$] while vehicle-injected birds did not. As a result, the analysis yielded a significant treatment by time interaction effect, $F(5,100)=8.78$, $p<0.001$. Differences in food intake between PRL and vehicle-injected birds were detectable on the first day of treatment and persisted throughout the injection period, $F(1,20)\geq 22.96$, $p<0.001$, for all comparisons.

Body weight differences between groups and sexes were similar to food intake differences [% body weight change: treatment, $F(1,20)=169.21$, $p<0.001$; treatment × sex, $F(1,20)=6.14$, $p<0.025$]. As depicted in Table 1, PRL-injected males gained significantly more weight than PRL-injected females, $F(1,20)=10.08$, $p<0.005$, and PRL-treated birds of both sexes gained more weight than did control animals [male: $F(1,20)=119.9$, $p<0.001$; female: $F(1,20)=55.44$, $p<0.001$]. In contrast, water consumption did not differ significantly between groups or between sexes during the treatment period (Table 1).

ICV Injection Study

Food intake. Daily food intake generally increased over the 5 days of treatment, $F(4,260)=59.46$, $p<0.001$, but, as shown in Fig. 2, changes over time were not uniform across groups [group × time, $F(32,260)=5.04$, $p<0.001$]. All groups except those given tPRL, 0.1 μg oPRL, or vehicle showed a significant increase in daily food intake over the treatment period, $F(4,260)\geq 7.64$, $p<0.001$, for all significant differences.

Significant differences in baseline food consumption across groups, $F(8,65)=2.17$, $p<0.05$, necessitated the use of relative changes in food intake (see the Method section) for analysis of treatment differences (Fig. 3). This analysis revealed a significant overall treatment difference, $F(8,65)=27.97$, $p<0.001$. All doses of oPRL except the lowest dose effectively elevated food consumption ($p<0.01$ for all comparisons) over that observed in the control group and did so in a dose-dependent fashion (0.1 vs. 0.5 and 0.5 vs. 2.0 μg/day, $p<0.01$). A significant increase in food intake was also observed in the three groups that received injections of GH ($p<0.01$ for all comparisons) and the food intake changes observed in these groups did not differ significantly from those observed in birds given the same dose of oPRL (1.0 μg/day). In contrast, no significant increase in food intake occurred in birds receiving tPRL. As shown in Table 2, a similar pattern of group differences was obtained when changes in food intake were based on the measurements made on the last day of injections rather than on average food consumption during the treatment period, $F(8,65)=32.36$, $p<0.001$.

Water intake. Water consumption varied significantly over the 5 day treatment period, $F(4,152)=6.74$, $p<0.001$. A treatment by time interaction was also observed, $F(32,152)=2.78$, $p<0.001$, with some groups exhibiting significant fluctuations in water intake over the injection period [0.1 μg oPRL, 2.0 μg oPRL, tGH and hGH, $F(4,152)\geq 2.82$, $p<0.03$ for all comparisons] and others showing no significant changes (veh, 0.5 μg oPRL, 1.0 μg oPRL, tPRL, and oGH).

As was the case in food intake analyses, group differences in water intake were based on average changes over the treatment period, since baseline values differed significantly across groups, $F(8,65)=2.84$, $p<0.01$. In addition, nonparametric statistical tests were used because preliminary tests revealed significant heterogeneity of variance on this measure [Levene's test, $F(8,65)=2.50$, $p<0.02$]. As shown in Fig. 4, the average change in water consumption during the

TABLE 2

EFFECTS OF INTRACEREBROVENTRICULAR INJECTIONS OF PROLACTIN OR GROWTH HORMONE PREPARATIONS ON FOOD INTAKE AND BODY WEIGHT IN MALE DOVES

Treatment Group	Daily Dose (μg)	N	% Increase From Baseline: Food Intake (Treatment Day 5)	% Increase From Baseline: Body Weight
Vehicle	—	8	13.7 ± 4.6	2.1 ± 0.7
oPRL	0.1	8	21.1 ± 5.9	5.8 ± 0.7
	0.5	10	71.6 ± 7.5*	14.9 ± 1.0*
	1.0	8	108.2 ± 7.9*	14.0 ± 0.8*
	2.0	8	119.4 ± 6.0*	16.0 ± 1.2*
tPRL	1.0	8	19.2 ± 5.3	3.2 ± 0.8
tGH	1.0	8	82.4 ± 9.0*	14.6 ± 0.8*
oGH	1.0	8	86.0 ± 10.1*	10.4 ± 1.6*
hGH	1.0	8	99.1 ± 10.1*	17.4 ± 1.2*

Birds were given 5 daily injections of purified prolactin (PRL) or growth hormone (GH) preparations of turkey (t), ovine (o), or human (h) origin. Food intake and body weight values for the last day of the treatment period were compared with average baseline values obtained during the 5 day period prior to treatment to yield the percentage values for each subject. Values depicted are group means ± SEM. Values that significantly exceeded vehicle control values are indicated (*$p<0.01$).

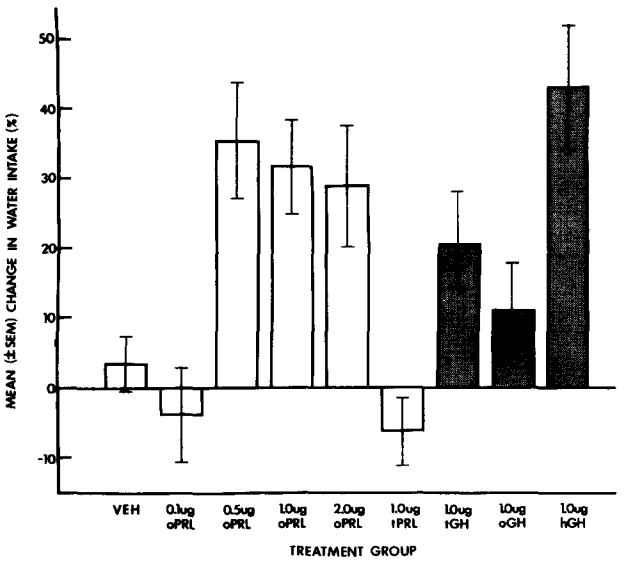

FIG. 4. Average % change in water intake (mean±SEM) in male doves given 5 daily intracerebroventricular injections of prolactin, growth hormone, or saline vehicle. See Fig. 2 for abbreviations. Daily water intake values for the 5 treatment days were averaged and compared with the average baseline value for the 5 days prior to treatment to yield percentage values for each subject (n=8 per group except 1.0 μg oPRL, n=10). Only the hGH and 0.5 μg oPRL groups differed significantly from controls ($p<0.01$).

treatment period varied significantly across treatment groups, $H(8)=32.37$, $p<0.001$. The three highest oPRL dose groups showed a significantly greater increase in water intake during the treatment period than did the 0.1 μg oPRL group ($p<0.02$ for all comparisons) but only the 0.5 μg dose groups differed significantly from vehicle-injected controls ($p<0.01$). In addition, no differences were observed among the 0.5 μg, 1.0 μg, and 2.0 μg dose groups (Fig. 4). Among the remaining treatment groups, only the hGH-injected animals differed significantly from vehicle-injected controls in water intake change ($p<0.01$). However, several other groups showed elevations in water intake that approached statistical significance (veh vs. 1.0 μg oPRL, 2.0 μg oPRL, tGH, or oGH, $p<0.10$).

Body weight and crop sac weight. Group differences in body weight changes over the treatment period were also observed, $F(8,65)=32.36$, $p<0.001$, and differences among individual groups generally paralleled the pattern observed in food intake analyses (Table 2). In contrast, crop sacs in all treatment groups were undeveloped and none of the PRL or GH groups showed evidence of significant crop sac growth in crop sac weight comparisons with the control group.

DISCUSSION

The results of this study demonstrate that oPRL is capable of elevating food intake when administered by central (ICV) or peripheral (subcutaneous) injection. Moreover, as has been observed following ICV injection (9), subcutaneous administration of oPRL induced a more pronounced hyperphagic response in males than in females. The degree to which feeding varies with PRL dosage following subcutaneous injections is unknown, but PRL-induced body weight changes, which in the present study were closely related to food intake changes, may be used to estimate this relationship indirectly. In a previous study involving subcutaneous injections of oPRL (29), a linear increase in body weight was observed over the entire range of doses tested (0.8 to 7.0 mg/kg). A comparison of this dose-response curve with that obtained in the present study with ICV-injected oPRL indicates that centrally and peripherally administered oPRL differ in relative potency by at least 3 orders of magnitude. This difference in effectiveness and the lack of PRL-dependent crop sac growth in ICV-injected animals suggest that oPRL is capable of acting centrally to promote feeding and body weight gain. Although it is unclear whether systemically administered oPRL gains access to and interacts with PRL-sensitive target sites in the brain to promote hyperphagia, there is evidence to support this possibility. While the blood-brain barrier would preclude direct CNS uptake of oPRL, circulating hormone could conceivably gain access to the brain by a blood-to-CSF transport mechanism located in the choroid plexus (32,61). Evidence for specific binding sites for PRL in choroid plexus in several mammalian species (52) and in the ring dove (10) provides support for this concept as does the recent finding in the rat that the choroid plexus is a site of saturable receptor-mediated transport of blood-borne PRL into the CSF (61).

Recent studies using ^{125}I-oPRL as a tracer have revealed sites which bind PRL with high affinity and high specificity in ring dove brain homogenates, with highest activity in diencephalic and telencephalic regions (8). Although the precise distribution of PRL-secreting cells in dove brain have yet to be mapped, these findings leave open the possibility that PRL acts directly at periventricular loci which have been implicated in the regulation of feeding activity [see

(30,46) for review]. Moreover, electrophysiological evidence for PRL-induced changes in neuronal activity in the ventromedial hypothalamus of the rat lends support to this view (11,62). Based on studies with other ICV-injected peptides (3, 41, 49), however, it is also conceivable, although perhaps not likely (20,55), that CSF-borne PRL alters food intake indirectly by travelling to the pituitary to alter hypophyseal function.

The marked hyperphagia and body weight increase induced by ICV injections of oPRL corroborate the previous report of Buntin and Tesch (9) and extend these results by demonstrating that these responses are dose-dependent with thresholds below 22 pmol (0.5 μg)/day. Although drinking was also elevated in most oPRL treatment groups, changes in water intake during the treatment period were less pronounced than changes in food consumption and were not strongly related to the dose of hormone administered. This suggests that the PRL-induced elevation in drinking activity is secondary to the hyperphagic response. Moreover, recent evidence that PRL does not elevate drinking in food-deprived animals supports this interpretation (unpublished observations).

The virtual doubling of daily food intake and the 15% increase in body weight which male doves in the 2.0 μg oPRL group exhibited over a 5 day period rivals that observed in rats following repeated intracranial injections of the most potent orexigenic agents known (39,57). However, the mechanisms by which PRL acts to promote these dramatic changes are poorly understood. As has been demonstrated for several other PRL-dependent changes (14), interactions between sex steroids and PRL could be involved in the PRL-induced feeding response since male doves showed more pronounced hyperphagia than females following systemic (Fig. 1) or ICV (9) administration of the hormone. However, a critical test of this hypothesis has yet to be conducted. PRL-induced stimulation of tuberoinfundibular dopamine synthesis and turnover has been reported in birds [see (28)] and is well documented in mammals (43). Moreover, PRL-induced changes have been observed in other dopaminergic systems (13,59). However, there is currently no compelling evidence that dopamine mediates the hyperphagic action of PRL. The effects of dopamine on feeding behavior are complex and site-specific [see (38,44) for review] and in the pigeon, the dopamine agonist apomorphine reportedly suppresses rather than facilitates feeding when given via peripheral injection (17). In addition, the neurochemical and electrophysiological changes induced by intracranial PRL administration can differ markedly from those induced by dopamine or dopamine agonists (11,33). PRL also reportedly stimulates the release of GABA and beta endorphin in rat hypothalamus (40, 50, 53) which in turn may stimulate feeding activity (15, 18, 27, 45). It is also conceivable that norepinephrine mediates the hyperphagic action of PRL (38); however, this hypothesis is difficult to evaluate because the effects of PRL on norepinephrine turnover in the hypothalamus appear to vary markedly between species (1). Other possibilities remain to be investigated including the interaction between PRL and other appetite-stimulating peptides such as NPY (31).

Growth hormone has been reported to promote food intake in several vertebrate species (2, 37, 51, 63) and our results with ICV-injected turkey, ovine, and human GH are consistent with these findings. Although quantitative estimates of relative potency cannot be calculated from single dose tests, food intake changes in the three GH groups were similar in magnitude to those observed with an equivalent dose of oPRL. Systemic injection studies in toads (63) and lizards (37) have yielded similar results, with bovine GH being equal or superior to oPRL in potency. Because hGH binds to PRL receptors as well as GH receptors in a variety of target tissues (48) and is a highly effective competitor of ^{125}I-oPRL in binding to dove brain membranes (8), the hyperphagic actions of hGH in doves could be explained at least in part by its PRL-like activity. In contrast, oGH and tGH are 50–100 times less effective than oPRL as a binding competitor of ^{125}I-oPRL in dove brain and liver membranes (6,8). Although the relationship between GH dose and feeding response must be established before definitive conclusions can be drawn, these data raise questions regarding the degree to which oPRL and the nonhuman GH preparations interact with the same class of binding sites to promote feeding activity.

The inability of turkey PRL to significantly augment food consumption contrasts markedly with the results obtained with the other PRL and GH groups, but is consistent with the rather weak receptor binding activity observed with this preparation in previous studies. The binding potency of the tPRL preparation that we used has been estimated by chicken kidney radioreceptor assay to be approximately $^1/_3$ that of oPRL (J. Proudman, unpublished results). In dove forebrain membranes, in contrast, this same preparation was 15 times less effective than oPRL as a binding competitor of ^{125}I-oPRL (8). Poor binding activity was also observed in dove liver membranes when a different preparation of purified tPRL was tested (6). Such differences in relative binding activity between oPRL and tPRL in dove tissues could help to explain the low orexigenic potency of tPRL. However, the apparent differences in binding potency of tPRL in doves and in gallinaceous birds makes it difficult to interpret the divergent feeding responses of turkeys and ring doves to this hormone (9,16). Additional information on the effects of oPRL on feeding behavior in turkeys would help to resolve these discrepancies as would feeding studies in doves using purified pigeon or dove PRL preparations.

While the effects of PRL and GH on food intake and body weight are dramatic in this species, the functional significance of these changes and their generality to other species require further study. Food consumption remains unchanged in breeding pairs of doves sampled during the incubation period when circulating PRL levels are rising, but it increases substantially during the second and third week of the posthatching period when PRL levels are declining (5,26). This raises questions regarding the relationship between circulating PRL levels and feeding activity in breeding doves. However, the issue is complicated by the fact that PRL may also promote the display of other behaviors such as nest attentiveness during the incubation and early posthatching period which are incompatible with the expression of feeding. Plasma levels of GH reportedly remain unchanged throughout the breeding cycle but do show seasonal fluctuations (34). Additional experimentation will be required to determine if these changes correlate with seasonal changes in feeding patterns in this nonmigratory species and to characterize the role of PRL and GH in regulating the marked hyperphagia and fattening observed in other avian species prior to migration.

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