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BRIEF COMMUNICATION

Play Soliciting in Juvenile Male Rats: Effects of Caffeine, Amphetamine and Methylphenidate

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THOR, D. H. AND W. R. HOLLOWAY, JR. *Play soliciting in juvenile male rats: Effects of caffeine, amphetamine and methylphenidate.* PHARMACOL. BIOCHEM BEHAV **19**(4) 725–727, 1983.—Three standard CNS stimulants were tested for effect on juvenile play soliciting in prepubertal male rats (n = 120). Three dosages of each stimulant were compared with a saline control. Soliciting behavior was isolated and magnified by a novel method incorporating pretest social deprivation and social response to a standard nonplayful social stimulus pretreated with scopolamine HBr. Caffeine significantly decreased frequency of play soliciting only at the high dose of 40 mg/kg. Methylphenidate and d-amphetamine significantly decreased play soliciting at all dosages tested. The method is proposed as a generally useful experimental paradigm in analyses of drug effects on play soliciting. Advantages include individual measures of soliciting behavior that correlate reliably with measures of rough-and-tumble play fighting.

Juvenile play Caffeine Amphetamine Methylphenidate Social play Play soliciting Scopolamine Rats

JUVENILE (post weaning to puberty) rats normally engage in social interaction that has been described as "rough-and-tumble" play fighting [3, 4, 6, 7, 8]. Elements of social play include wrestling, boxing, pinning, and chasing. Such play occurs in bouts or sequences consisting of a rapid and fluid exchange of socially directed behaviors, normally elicited by one juvenile that emits one or more inciting, soliciting, or play-signaling behaviors to one or more other juveniles. Play initiation behaviors have been observed and reported by a number of investigators [3,4, 6, 8].

Research efforts have typically concentrated on distinctive and unambiguous measures of play fighting readily subject to quantification and highly correlated with other measures of play fighting [2,6]. Observation of play initiation has been limited to observing the identity of individuals in a group initiating play and scoring the number of play initiations for successive play bouts [4]. Such measures are positively correlated with other measures of social play [8] and suggest that eliciting behavior is, in fact, sufficiently detectable to effectively score by direct observation. The difficulty lies in the apparent unity of initiating behaviors with interactive play fighting behaviors that involve two or more participants. Initiating behavior readily blends or merges into other forms of rough-and-tumble play.

In this laboratory we have recently found that soliciting behavior is more readily observable when a normal juvenile is socially isolated for several days and exposed to a socially attractive but nonplayful juvenile stimulus [10]. We have used scopolamine HBr to induce a nonplayful state without inhibiting normal movement or interferring with social attraction to other juveniles [9]. By this method, play soliciting by a normal juvenile to a scopolamine-treated social stimulus may be observed in the near absence of social response by the stimulus. This play soliciting behavior continues intermittently for 10–15 min, gradually waning with lack of social reinforcement [10].

The present design compared three CNS stimulants which have been demonstrated as reliably affecting play fighting in paired juvenile rats. Our purpose was not to replicate these studies but to observe the effect of these stimulants upon play soliciting measures of juvenile social behavior. Since play soliciting behaviors are reported as positively and reliably correlated with play fighting behaviors, we anticipated comparable effects, viz, inhibition of soliciting behavior. Our measures, however, apply to individual juveniles rather than to joint measures (e.g., pinning, wrestling, boxing) contingent on interactive play fighting.

METHOD

Animals

Subjects were 120 male Long Evans hooded rats, 30–40 days of age, assigned to ten groups of twelve. Six days before testing, each juvenile was socially isolated in a separate cage (41×51×22 cm). Twenty-four additional juveniles of the same age, sex, and strain were used as social stimuli and

were socially housed in groups of four per cage when not in use.

Treatments

Test exposures were made by inserting a scopolamine-treated social stimulus into the home cage of a subject. Scopolamine HBr (Sigma) dosage was 10 mg/kg by IP injection 15 min prior to test exposure. Each subject in the control group (n=12) received an IP injection of physiological saline in volume of 0.1 ml/100 g 15 min prior to test. Independent experimental groups received anhydrous caffeine (Sigma) in dosages of 10, 20, or 40 mg/kg; d-amphetamine sulfate (Smith Kline Corp.) in dosages of 0.5, 1, or 2 mg/kg; or methylphenidate HCl (Ciba-Geigy) in dosages of 0.5, 1, or 2 mg/kg. Dosages were selected on the basis of comparable range in affecting play fighting [1, 2, 5]. All drugs were administered IP in a saline vehicle 15 min prior to test.

Observations

Soliciting behaviors observed and recorded included dart and crossover frequency. These two measures appear more useful than other soliciting behaviors (tail-pull, aggressive groom) since they normally occur with higher frequencies and are unambiguous in character [10]. A *dart* may be defined as a quick run with an abrupt start and stop, usually in a direction away from the stimulus; this behavior is comparable to the dart of an estrous female in response to the presence of a mature male. A *crossover* may be defined as any body movement that results in a traversal over or under the stimulus animal (over occurs considerably more frequently than under). Speed of traversal may vary from a slow crawl to a fast run. Incomplete traversals, such as a mount, were not scored.

Observation of each subject continued to a behavioral criterion of no dart or crossover for an interval of 60 continuous seconds (arbitrarily selected and based upon preliminary observations). We measured latency to initial solicitation (first dart or crossover) and time to criterion (interval from first solicitation to end of the 60-sec period of no solicitation). All observations were made in dim red light during the normally dark phase of a 12:12 hr, light-dark cycle. Food and water were continuously available throughout.

RESULTS

Scopolamine treated social stimuli were effective in promoting play soliciting behavior of saline treated controls. Scopolamine increases ambulation [10] and all stimuli were normally mobile during observation. Stimuli appeared to be intently investigating the novel physical environment and rarely attended to subjects, even when the subjects repeatedly engaged in a variety of soliciting behaviors. Consequently, a near absence of typical, interactive juvenile play was observed (wrestling, tumbling, chasing, pinning, boxing). In sharp contrast with the subjects, stimuli did not engage in play soliciting behaviors. This lack of propensity to engage in initiation of social play or to respond to play soliciting behaviors by other juveniles allows a relatively unconfounded measure of individual play soliciting to a standard social stimulus (scopolamine treated juvenile).

Means and variances for all measures for each treatment group are given in Table 1. One way ANOVAS were computed for each measure across dosage treatments for each drug. Mean treatment differences were analyzed by Dunnett's Test for mean comparisons with a control. Asterisks and daggers in Table 1 refer to means that differ significant from that of the control group.

Caffeine

Dosage treatments differed significantly for Crossover, $F(3,44)=12.76$, $p<0.001$. Dart, $F(3,44)=6.26$, $p<0.002$. Latency to Solicit, $F(3,44)=7.24$, $p<0.001$, and Time to Criterion, $F(3,44=8.21$, $p<0.001$.

Dosages of 10 and 20 mg/kg did not differ significantly from saline control on any measure. The largest caffeine dose (40 mg/kg significantly ($p<0.01$) decreased time to criterion as well as dart and crossover frequencies and increased latency to solicit ($p<0.01$).

Amphetamine

Dosage treatments differed significantly for Crossover, $F(3,44)=36.31$, $p<0.001$. Dart, $F(3,44)=23.04$, $p<0.001$, Latency to Solicit, $F(3,44)=3.14$, $p<0.05$, and Time to Criterion, $F(3,44)=18.16$, $p<0.001$.

Crossover and dart frequencies for 0.5, 1 and 2 mg/kg dosages were all significantly ($p<0.01$) lower than control. Latency to solicit increased with higher dosages of amphetamine; dosages of 1 and 2 mg/kg were significantly ($p<0.05$) longer than control latency. Time to criterion decreased with increasing dosages; all dosages were significantly ($p<0.01$) less than control.

Methylphenidate

Dosage treatments differed significantly for Crossover, $F(3,44)=6.57$, $p<0.001$. All other measures did not differ significantly ($p>0.05$).

All dosages of methylphenidate significantly ($p<0.01$) decreased crossover frequency from control level. Dunnett's tests also indicated a significant ($p<0.05$) decrease in dart frequency at the highest dose (2 mg/kg). Time to criterion was also significantly ($p<0.05$) less than for control at the highest dosage of methylphenidate. All mean latencies to solicit failed to differ significantly from the control mean.

DISCUSSION

Mean dart and crossover frequencies were nonsignificantly greater for juveniles treated with 10 mg/kg caffeine than for controls. After 20 mg/kg of caffeine mean dart frequency and crossovers were nonsignificantly less than control. Only at 40 mg/kg did crossover frequency differ significantly from the control group, and even at this dose, mean darting frequency was nonsignificantly different from control. The absence of a caffeine effect on play soliciting at a moderate dosage in the present study contrasts with a reliable decrease in play fighting previously observed after 10 mg/kg to the resident member of a pair in juveniles 30–35 days old (the social stimulus was untreated—unpublished observations).

Amphetamine was effective at the lowest dose of 0.5 mg/kg; mean decreases in crossover and dart frequencies were both significantly depressed. Amphetamine also decreased time to criterion at the 0.5 mg/kg dose. Methylphenidate, even at the highest dose (2 mg/kg), did not depress Crossover, Dart or Time to Criterion measures as much as amphetamine at the lowest dose (0.5 mg/kg). Latency to solicit play was relatively unaffected by methylphenidate at all dosages.

Significant decreases in play fighting were found by Beatty *et. al.* [1] when paired juvenile rats were both given

TABLE 1

MEANS AND VARIANCES‡ OF PLAY SOLICITING BEHAVIORS, LATENCY TO SOLICIT PLAY AND TIME TO CRITERION

Treatment	N	Dose§	Latency to solicit play (sec)	Solicitation Frequency		Time to Criterion (sec)
				Crossover	Dart	
Saline	12	0	49.5 ± 10.8	16.6 ± 1.8	7.6 ± 1.3	352.1 ± 41.3
Caffeine	12	10	45.1 ± 9.7	18.4 ± 3.0	13.9 ± 2.9	375.8 ± 42.5
	12	20	116.6 ± 26.0	9.0 ± 2.8	8.5 ± 2.2	299.1 ± 55.6
	12	40	157.8 ± 27.5†	0.9 ± 0.3†	2.1 ± 1.8	114.2 ± 15.7†
Amphetamine	12	0.5	116.1 ± 21.0	4.9 ± 1.3†	1.9 ± 0.6†	190.0 ± 36.9†
	12	1.0	123.0 ± 27.8*	2.1 ± 0.4†	0.2 ± 0.1†	97.6 ± 17.9†
	12	2.0	128.9 ± 20.3*	1.5 ± 0.5†	0.2 ± 0.1†	74.7 ± 10.6†
Methylphenidate	12	0.5	58.4 ± 13.9	9.1 ± 1.3†	5.9 ± 1.5	256.4 ± 32.3
	12	1.0	74.0 ± 10.3	7.2 ± 1.9†	3.8 ± 1.6	224.8 ± 44.8
	12	2.0	65.6 ± 11.2	7.9 ± 1.6†	2.7 ± 0.9*	212.9 ± 34.5*

‡ ± S.E.
§mg/kg.
Significantly different from control (saline) *$p < 0.05$, †$p < 0.01$.

amphetamine or methylphenidate; amphetamine at doses of 0.5 mg/kg or greater and methylphenidate at doses of 2 mg/kg or greater reliably depressed pinning and play fighting time. Humphreys and Einon [3] also observed paired juvenile rats given amphetamine; and in one of their experiments (Experiment 3) one member of a pair receiving a 2 mg/kg dose was described as engaging in less play but in more social behaviors such as sniffing and crawling over/under the nondrugged member of the pair.

The present results are in agreement with the findings of others with reference to the general effect of CNS stimulants on social play. Play soliciting, as determined by individual exposure of juveniles to nonplayful cagemate conspecifics, is a sensitive and discriminating measure of motivation to engage in play. Evidently, play soliciting and play fighting differ in sensitivity to stimulant drugs.

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