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Comparison of daily and monthly pyrantel treatment in yearling Thoroughbreds and the protective effect of strategic medication of mares on their foals

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Abstract

Studies on a Thoroughbred breeding farm in Ohio were done to: (1) compare the effects of daily administration of pyrantel tartrate feed pellets with monthly administration of a pyrantel pamoate paste to yearling horses (21 January–3 September); (2) assess the effects of daily pyrantel tartrate given strategically in spring/summer to foaling mares (1 April–16 August) and given for a prolonged period to barren mares (21 January–3 September); (3) determine if strategic medication of foaling mares with daily pyrantel tartrate protected their foals until weaning.

There were no differences in cyathostome egg counts, pasture larval counts, body condition scores, or body weights of yearlings treated with daily pyrantel tartrate or monthly pyrantel pamoate. Both treatments failed to maintain fecal egg counts of yearlings below 100 eggs per gram (epg), and mean counts exceeded 400 epg (pyrantel pamoate) and 700 epg (pyrantel tartrate) in August and September, resulting in a sharp, but moderate increase in pasture infectivity in October. By contrast, prolonged or strategic use of daily pyrantel tartrate in mature horses were each highly effective in reducing pasture contamination and infectivity with cyathostome eggs and larvae respectively. Strategic medication of foaling mares provided protection of their foals until weaning and first treatment of foals was delayed until after weaning when mean strongyle counts exceeded 100 epg. Treatment of weanlings with pyrantel pamoate had little effect on egg counts. A comparative anthelmintic study with ivermectin, oxibendazole, and pyrantel pamoate confirmed earlier studies showing reduced efficacy of anthelmintics in young horses.

Keywords: Horse; Cyathostomidae; Control methods-Nematoda; Pyrantel pamoate; Pyrantel tartrate

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1. Introduction

The tetrahydropyrimidine anthelmintic pyrantel tartrate (Strongid C, Pfizer, Inc., New York) has been marketed for administration to horses at a low daily dosage of 2.64 mg kg^{-1} in alfalfa/molasses pellets since 1990. There are, however, few reports of its efficacy apart from published accounts of two roundtable discussions sponsored by the manufacturers of the product (Anonymous, 1990; Anonymous, 1992), but much of the content was based on anecdotal evidence with little experimental data. Several questions remain to be answered about this anthelmintic program for equines.

In this study, we attempted to determine: (1) if there is any advantage in the daily administration of pyrantel tartrate (2.64 mg kg^{-1}) feed pellets (Strongid C) over monthly administration of a conventional pyrantel pamoate (6.6 mg kg^{-1}) paste (Strongid P) in yearling Thoroughbred horses; (2) if there is any advantage of prolonged daily feeding of pyrantel tartrate compared with strategic (spring/summer) daily feeding of pyrantel tartrate in mature mares; (3) if strategic medication of foaling mares with pyrantel tartrate in spring and summer ensures safe pastures and protection of their foals until weaning.

2. Materials and methods

Observations were made in 1991 at Woodburn Farm, a Thoroughbred breeding farm in southern Ohio, where foaling occurs from January to June, and most foals are weaned in August and September. This farm was described in a previous paper reporting the reduced efficacy of ivermectin, oxibendazole, and pyrantel pamoate in young compared with adult horses (Herd and Gabel, 1990).

2.1. Yearlings

Thirteen colts were randomly divided into two groups of six and seven animals of similar body weight, and ten fillies were randomly divided into two groups of five animals of similar body weight. Measurements and observations were made on the dates shown in Figs. 1 and 2, and Table 1. The colts and fillies each grazed separate pastures throughout the treatment period from 21 January to 3 September, after which they left the farm. They were given the following treatments:

Group 1 (seven colts): pyrantel tartrate daily;
Group 2 (six colts): pyrantel pamoate every 4 weeks;
Group 3 (five fillies): pyrantel tartrate daily;
Group 4 (five fillies): pyrantel pamoate every 4 weeks.

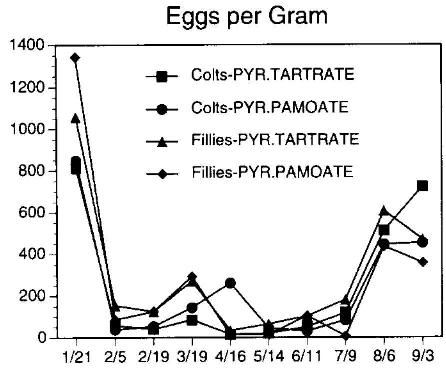

Fig. 1. Mean strongyle egg counts from 21 January to 3 September of two groups of yearling colts and two groups of yearling fillies treated with pyrantel tartrate daily or pyrantel pamoate every 4 weeks.

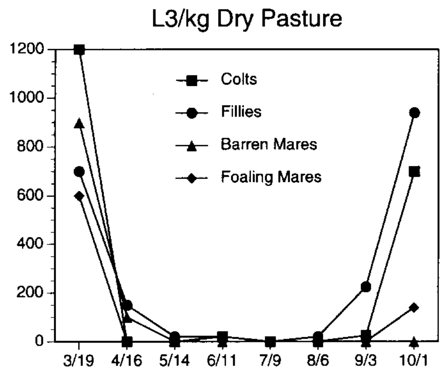

Fig. 2. Pasture larval counts at 4 week intervals from March to October of pastures grazed by yearling colts, yearling fillies, barren mares, and foaling mares and their foals.

Table 1
Mean body condition scores[a] of yearling colts, yearling fillies, barren mares, and foaling mares

	21 Jan.	19 Feb.	19 Mar.	16 Apr.	14 May	11 June	9 July	6 Aug.	3 Sept.
Yearling colts given daily pyrantel tartrate or monthly pyrantel pamoate									
Daily	4.7	5.0	5.3	5.0	5.4	5.6	6.0	6.3	6.3
Monthly	4.7	5.2	5.2	5.2	5.4	5.4	6.0	6.2	6.2
Yearling fillies given daily pyrantel tartrate or monthly pyrantel pamoate									
Daily	4.6	5.0	5.2	5.4	6.0	6.0	6.2	6.2	6.6
Monthly	4.8	5.2	5.4	5.4	6.2	6.2	6.4	6.4	6.8
Mares given daily pyrantel tartrate									
Barren	4.8	5.0	5.4	5.9	6.3	7.3	7.7	8.0	8.0
Foaling	5.9	5.9	–	–	–	–	–	7.9	7.3

[a]Body condition scores: 8, overweight; 6, optimum; 4, ribs visible; 2, backbone visible.

2.2. Mares

Comparisons were made between a large group of barren mares and a large group of foaling mares treated with pyrantel tartrate as follows:

Foaling mares: pyrantel tartrate daily, strategic treatment 1 April to 16 August.

Barren mares: pyrantel tartrate daily, prolonged treatment 21 January to 3 September.

It was originally planned to medicate barren mares daily from 21 January until the end of the year, but feeding of pellets was discontinued on 3 September when mares became overfat. It was also planned to administer pyrantel tartrate daily to foaling mares strategically from 1 April to 31 August to eliminate the spring/summer rise in fecal egg counts (Herd et al., 1985), but treatment was terminated 2 weeks early on 16 August to help reduce milk production by mares after weaning foals. The mares were given a single treatment of Strongid P within 4 days of foaling, but no other treatments in 1991. Measurements and observations were made on 7–16 barren mares and 9–26 foaling mares on the dates shown in Figs. 2 and 3, and Table 1.

2.3. Foals

Measurements and observations were made on 23 foals of medicated mares from 14 May to 10 December on the dates shown in Figs. 2 and 4, and Table 2. Foal treatments were not initiated until mean strongyle or ascarid egg counts exceeded 100 eggs per gram (epg) of feces. This did not occur until 3 September after the foals were weaned. Weanlings were then treated on 3 September and 1 October with pyrantel pamoate paste. They were randomly allocated to three groups of eight, eight, and seven weanlings on the basis of their 1 October egg counts and treated with 0.2 mg kg^{-1} of ivermectin (Zimecterin, Farnam Companies, Inc., Phoenix), 10 mg kg^{-1} of oxibendazole (Anthelcide, SmithKline

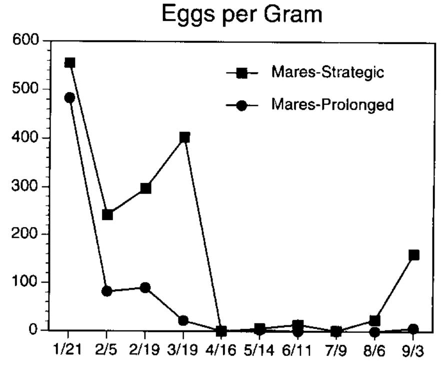

Fig. 3. Mean strongyle egg counts of barren mares given daily pyrantel tartrate continuously from 21 January to 3 September, and foaling mares given daily pyrantel tartrate strategically from 1 April to 16 August.

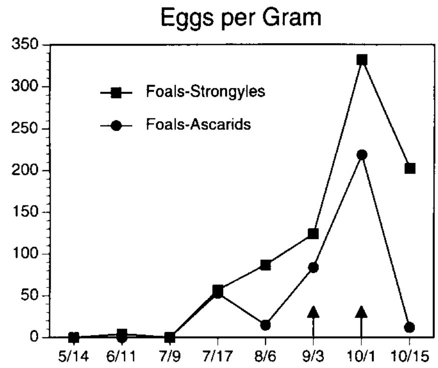

Fig. 4. Mean ascarid and strongyle egg counts of 23 foals of mares given strategic daily medication with pyrantel tartrate. Weanlings were treated with pyrantel pamoate paste on 3 September and 1 October (arrows).

Table 2
Mean strongyle egg counts of 23 weanlings randomly allocated to three groups and treated with ivermectin, oxibendazole, or pyrantel pamoate on 15 October, and with oxibendazole or pyrantel pamoate on 12 November

1 Oct.	15 Oct.		28 Oct.	12 Nov.		26 Nov.	10 Dec.
epg[a]	epg	Treatment	epg	epg	Treatment	epg	epg
357	132	Ivermectin	5	6	–	10	317
323	133	Oxibendazole	53	96	Pyrantel	141	418
317	323	Pyrantel	524	607	Oxibendazole	194	330

[a]Eggs g^{-1} of feces.

Beecham, Pennsylvania), or 6.6 mg kg^{-1} of pyrantel pamoate (Strongid P, Pfizer, Inc., New York) on 15 October to compare the ability of each drug to suppress fecal egg counts at 2 week intervals post treatment. There was a cross-over of treatments in the oxibendazole and pyrantel pamoate groups on 12 November, and further observation of fecal egg counts until 10 December.

2.4. *Measurements and observations*

The effects of treatment were assessed by the following parameters on the dates shown in the figures and tables.

2.4.1. *Parasitologic evaluations*

Quantitative fecal egg counts were done by the modified McMaster technique (Whitlock, 1948) to detect egg counts as low as 8 epg. Larvae were cultured and differentiated by a modification of the method of Russell (1948) from all fecal samples collected in January and October. Pasture samples were collected by a modification of the method of Taylor (1939) to sample lawns grazed by horses for the reasons described by Herd and Willardson (1985). Infective larvae were recovered by a modified Baermann technique using water heated to 40°C (Herd, 1985), with collection of larvae after 36 h at room temperature. Pasture samples were collected at the same time each morning (09:00–11:00 h).

2.4.2. Clinical/performance evaluations

Body condition scores were ranked from 1 to 10 (8, overweight; 6, optimum; 4, ribs visible; 2, backbone visible). Horses were weighed by electronic scales with an accuracy of ± 0.2 kg at the start and finish of the study. All horses were observed daily for anorexia, diarrhea, colic, or other adverse effects.

2.4.3. Statistics

The Kruskal–Wallis test was used to compare fecal egg counts among the three weanling groups. If this test showed significant differences ($P<0.05$) among the groups, multiple pairwise comparisons were done using the Dunn procedure. These non-parametric tests were used due to the small numbers of horses and the non-normal distribution of egg counts.

2.4.4. Efficacy of anthelmintics

As described in the study of Herd and Gabel (1990), the efficacy of anthelmintics was assessed by the ability of pyrantel salts or oxibendazole to keep mean fecal egg counts below 100 epg for 4 weeks after treatment, and for ivermectin to do the same for 8 weeks after treatment because of its more prolonged effect on worm egg suppression.

3. Results

3.1. Yearling colts and fillies

Initially there was a 85–96% reduction in strongyle egg counts of colts and fillies 2 weeks after initiation of monthly pyrantel pamoate or daily pyrantel tartrate medication, but continued medication with both formulations frequently failed to keep mean strongyle egg counts below desired levels of 100 epg. In August and September, mean strongyle egg counts rose to 723 epg (colts) and 608 epg (fillies) for daily pyrantel, and 454 epg (colts) and 435 epg (fillies) for monthly pyrantel (Fig. 1). Individual counts were as high as 1584 epg (pyrantel tartrate) and 992 epg (pyrantel pamoate). Ascarid counts were low at the start of the study (mean counts 38–154 epg) and zero counts observed from March to September were attributed partly to increasing immunity. Pasture larval counts of yearlings rose in September and October (Fig. 2) following marked increases in fecal egg counts in August and September.

There were no differences in body condition scores (Table 1), or body weights of colts and fillies treated with monthly pyrantel or daily pyrantel. Mean body weights of yearling colts at the start and finish of the study were 297 kg and 417 kg (pyrantel tartrate) and 306 kg and 416 kg (pyrantel pamoate). Mean body weights of yearling fillies at the start and finish of the study were 298 kg and 437 kg (pyrantel tartrate) and 296 kg and 443 kg (pyrantel pamoate).

3.2. Mares

Daily administration of pyrantel tartrate was highly effective in keeping mean strongyle egg counts less than 100 epg during the January to September treatment period for barren mares and the April to August treatment period for foaling mares (Fig. 3). Pasture larval counts were negligible for both groups following death of the previous years overwintered larvae (Fig. 2). In foaling mares there was a small increase in fecal egg counts and pasture larval counts after the cessation of daily pyrantel tartrate supplementation (Figs. 2 and 3).

Barren mares showed increasing body condition scores from January to September, when they were classified as overweight (Table 1). Mean body weights rose from 514 kg at the start of the study to 606 kg at the end of the study. Foaling mares, by contrast, showed smaller gains in body condition scores (Table 1) and a reduction in mean body weight from 594 to 564 kg. These changes were associated with pregnancy, improving pasture conditions, and feeding of medicated alfalfa pellets in both groups, but foaling mares were also subjected to the stress of foaling and lactation.

3.3. Foals

Fecal egg counts of 23 untreated foals of medicated mares were negligible until July, and neither strongyle nor ascarid counts exceeded mean counts of 100 epg until September 3, after foals were weaned (Fig. 4). Treatments with pyrantel pamoate paste on 3 September and 1 October had little effect on strongyle or ascarid egg counts, although a mean ascarid count of 219 epg after the first treatment was due largely to one foal with a count of 3408 epg. Results of a comparative anthelmintic trial with ivermectin (Zimecterin), oxibendazole (Anthelcide), and pyrantel pamoate (Strongid P) confirmed the failure of monthly pyrantel treatment to suppress mean strongyle egg counts below 100 epg (Table 2). Strongyle egg counts of pyrantel treated weanlings were significantly ($P<0.05$) higher than those for the ivermectin or oxibendazole treated weanlings 4 weeks post treatment on 12 November. However, results 4 weeks after the cross-over between oxibendazole and pyrantel pamoate treatments showed that mean strongyle counts of weanlings in all three groups had exceeded 300 epg, including a mean count of 317 epg for the ivermectin group 8 weeks post treatment.

3.4. Larval cultures

Both larval cultures and pasture larval examinations confirmed previous observations that cyathostomes accounted for 100% of strongyles on the farm. The large strongyles (*Strongylus vulgaris* and *Strongylus edentatus*) have not been observed on this farm since 1984 (Herd and Gabel, 1990).

3.5. Clinical observations

The pyrantel tartrate medicated alfalfa/molasses pellets were safe and palatable, although horses occasionally failed to consume their full ration. There were no adverse effects of treatment in any group.

4. Discussion

A comparison of daily pyrantel tartrate and monthly pyrantel pamoate in yearling Thoroughbred colts and fillies showed no differences in cyathostome egg counts, pasture larval counts, body condition scores, or body weights. Both treatments were unsatisfactory in controlling strongyle egg counts. Mean counts frequently exceeded 100 epg and rose above 400 epg (pyrantel pamoate) and 700 epg (pyrantel tartrate) in August and September, resulting in a sharp, but moderate increase in pasture infectivity with cyathostome larvae in October. By contrast, the prolonged or strategic use of pyrantel tartrate in mature mares was highly effective in reducing both pasture contamination and pasture infectivity with cyathostome eggs and larvae respectively. Mean fecal egg counts were consistently below 100 epg during the medication periods, and pasture larval counts were negligible.

Foals of mares given strategic medication with pyrantel tartrate grazed safe pastures and did not require treatment until after weaning. However, treatment of weanlings with pyrantel pamoate on 3 September and 1 October had little effect on fecal egg counts (Fig. 4). A comparative anthelmintic study initially showed significantly higher fecal egg counts for weanlings given pyrantel pamoate than for weanlings given ivermectin or oxibendazole, but mean counts for all three groups eventually exceeded 300 epg at 4 weeks post oxibendazole or pyrantel treatment, and 8 weeks post ivermectin treatment.

Poor results obtained in weanlings and yearlings in this study confirmed previous results on the same farm showing reduced efficacy of anthelmintics (ivermectin, oxibendazole, pyrantel pamoate) in young compared with adult horses (Herd and Gabel, 1990). However, it seemed unlikely that the failure of pyrantel salts was due to drug resistance because both pyrantel salts were effective in mares. As in the previous study, the problem appeared to be more age-related than drug-related. Although yearlings may have been exposed to a different population of cyathostomes with different selection pressures for drug resistance than mares, this was not the case with weanlings. They were exposed to the same cyathostome population as their dams from birth until 1 October, when they were moved to yearling pastures. During August and September weaning, the mares were moved out, while the weanlings remained on the pasture. The only published report of possible pyrantel pamoate resistance in horses was in yearling Thoroughbreds

(Drudge et al., 1988). It is possible that an age effect may also have contributed to this result. Differences in immunity between young and mature horses might result in marked differences in encystment, hypobiosis, prepatent periods, and egg counts, leading to poor treatment results.

Herd and Gabel (1990) suggested that yearlings may accumulate large numbers of encysted cyathostomes in the large intestinal mucosa because of their lack of immunity. Foals would have least immunity, but the gradual accumulation of encysted larvae might not peak until they were yearlings. A pre-existing population of encysted larvae would be little affected by anthelmintic treatment and could provide a major reservoir to replenish the adult worm population and pasture contamination. Nevertheless, the finding of high cyathostome fecal egg counts in yearlings in the present study does not necessarily mean that they carried heavy infections or were candidates for larval cyathostomosis. A small number of maturing cyathostomes could be expected to provoke little immune response and to lay eggs at their full capacity free of any immune suppression of egg production.

These results suggested the need for a re-appraisal of pyrantel tartrate use, especially on farms with a high density of horses.

(1) Daily medication of horses is likely to be very effective in mature horses, but may fail to provide adequate protection for weanlings and yearlings.

(2) Strategic medication of mares in spring/summer in northern latitudes may be just as effective as medication all year, thus reducing cost, labour, and selection for drug resistance.

(3) Strategic medication of foaling mares may ensure safe pastures and protection for foals until weaning time, thus delaying the first treatment of foals for several months and further reducing selection for drug resistance.

According to the manufacturers, the major advantage of daily administration of pyrantel tartrate over other systems is that it kills incoming strongyle larvae before they start their harmful tissue migrations. Thus, it appears ideal for use in situations such as boarding stables where treated horses may have to share pastures heavily contaminated by untreated horses. In these circumstances, medicated horses would still ingest infective larvae, but many would be killed in the gut before undergoing tissue migration. A Morris Animal Foundation study on equine risk factors (Reeves, 1993) indicated that horses given daily pyrantel treatment were less likely to be affected by colic. However, caution was urged in the interpretation of these results, because only 13 of the 812 horses surveyed had been given the product.

Bello and Laningham (1992) disputed the ability of pyrantel tartrate to prevent intestinal penetration and development of cyathostome larvae in yearling horses, despite finding better weight gains and reduced intestinal inflammation and edema in a treated group of six horses (three adults, three yearlings), compared with six control horses (one yearling only). Treated horses were given pyrantel tartrate for 14 days while undergoing challenge with approximately 16 667 cyathostome larvae per horse per day for 12 days. More 'coiled larvae' were detected in the cecal and colonic mucosa of the three treated yearlings by mural transillumination at necropsy 2 weeks later than in the controls. However, the horses used by Bello and Laningham (1992) had a pre-existing cyathostome infection prior to the study which was not removed by treatment with a 50 mg kg^{-1} dosage of oxfendazole. At necropsy, it would not have been possible to differentiate mucosal larvae of the experimental infection and the pre-existing infection. The failure of oxfendazole was not surprising (Reinemeyer and Herd, 1986a) and it has never been claimed by Pfizer that pyrantel tartrate will remove pre-existing encysted larvae.

The study by Bello and Laningham (1992) also raised some important questions about experimental horses and worm recovery techniques used in equine drug trials or studies on parasite population dynamics. In some recent papers (Bello and Laningham 1992; Love and Duncan, 1992), great reliance was placed on the use of 50 mg kg^{-1} oxfendazole or repeated doses of 7.5 mg kg^{-1} fenbendazole to remove pre-existing cyathostome infections, and on a transillumination technique for counting mucosal larvae at necropsy. The use of unproven 'larvicidal' drugs may seriously confuse the results, and dependence on the transillumination technique may mean that only a small fraction of mucosal worms are counted. The transillumination technique of Reinemeyer and Herd (1986b) was not designed to detect early third stage larvae (L_3) which are too small to be seen. It detects only late L_3 and fourth stage larvae (L_4). For complete results, it is necessary to count the more advanced L_3 and L_4 by transillumination, then scrape the mucosa and digest it in pepsin/hydrochloric acid to recover early L_3 (Eysker et al., 1988). Lack of data on early L_3 (arrested or developing) is a serious omission because they are sometimes present in enormous numbers, even exceeding 1 million per horse.

Some of the anecdotal evidence regarding daily medication of horses with pyrantel tartrate requires further evaluation. It has been described as the first preventive parasite control program for horses (Anonymous, 1990, 1992), but this is true only in the sense that medication may kill newly ingested larvae before they cause migratory damage. Preventive parasite control programs have been used ever since Drudge and Lyons (1966) showed that serious pasture contamination, parasitism, and colic could be prevented by treating horses with conventional dewormers at intervals within the egg reappearance period. Thus, effective prevention can be achieved with conventional anthelmintics if they are given at the appropriate intervals and periods of the year. Although this does not stop reinfection from pasture between treatments, the reduced egg output eventually results in safe pastures after older pasture larvae have died off. Studies in Texas showed that ivermectin treatments every 8 weeks were just as effective as the daily use of pyrantel tartrate (Craig et al., 1993), and results of the present study showed that pyrantel pamoate treatments every 4 weeks gave similar results to daily pyrantel tartrate medication of yearlings.

Claims of zero or near zero egg counts with the daily pyrantel tartrate regimen (Anonymous, 1990, 1992) is a cause of concern, although it is clear from the present results that this does not always happen. A lack of pasture contamination and infectivity could seriously interfere with the development of immunity and lead to larval cyathostomosis and colic if horses later grazed unsafe pastures. It was shown by Klei et al. (1992) in Louisiana that foals reared without the benefit of anthelmintic treatment showed signs of protective resistance to challenge with large and small strongyles, whereas foals reared on a daily pyrantel tartrate regimen did not. Claims of increased feed efficacy appear to be based largely on anecdotal evidence and require further scrutiny. These claims were not supported by the results of Craig et al. (1993) in Texas.

The need to give horses year round medication with daily pyrantel tartrate is debatable. Herd (1992a) recommended strategic spring/summer treatment with daily pyrantel tartrate for adult horses in northern temperate latitudes to reduce cost, selection for drug resistance, and interference with the development of immunity. In the present study, strategic treatment of mares with pyrantel tartrate was highly effective in ensuring safe pastures for suckling foals and there was no need to start foal medication at 8 weeks of age as often recommended. Fecal egg counts should be done before foal medication is started, and treatments initiated only if mean ascarid or strongyle counts exceed 100 epg (Herd, 1992b). It is also considered desirable to rotate anthelmintics on an annual basis to slow the spread of anthelmintic resistance, and to avoid using a rapid rotation or the same drug year after year (Herd, 1992a).

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