FOSTERING LAMBS BY ODOR TRANSFER: THE ADD-ON EXPERIMENT

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ABSTRACT

Lamb-specific odor is used by ewes to discriminate between their own and alien offspring. Recent studies have demonstrated that fostering can be facilitated by transferring own-lamb odor to alien lambs via cloth stockinettes. The objective of the present study was to investigate the effectiveness of the odor-transfer technique in enticing ewes with a single lamb to adopt an additional lamb ("add-on" procedure). Shortly after birth, nylon stockinettes were placed on the single offspring of 49 ewes and 49 additional alien lambs designated for fostering. Approximately 20 h following parturition, stockinettes were removed from 41 natural lambs and placed on alien lambs (experimental treatment). In the control treatment (eight ewes) own and alien lambs retained their own stockinettes. Four acceptance tests were conducted, 24 h apart, starting at the onset of fostering. Successful adoptions were attained for 21 of 31 experimental ewes (68%) exposed to add-on lambs similar in facial coloration to their own lambs. Only 2 of 10 experimental ewes (20%) with whiteface natural lambs adopted blackface add-on lambs. One of eight control ewes (12.5%) adopted an add-on lamb. Of the 24 ewes that adopted alien lambs 10 (41.7%) demonstrated immediate acceptance and 20 (83.3%) had adopted lambs by the second test day. A higher proportion of primiparous than multiparous ewes adopted alien lambs. The presence of own-lamb odor on stockinettes worn by add-on lambs appears to facilitate fostering. However, the presence of own-lamb odor may not be a significant enough cue to override obvious differences in facial coloration between own and add-on lambs. Lamb-specific odor transfer is an effective and efficient method for managing ewes to rear additional lambs.

(Key Words: Sheep, Lambs, Maternal Behavior, Olfaction.)

Introduction

Many ewes bearing single lambs can produce enough milk to support two offspring. Development of a relatively rapid and inexpensive technique to facilitate adoption of a second lamb would enhance the efficiency of many sheep production programs. Recent studies (Price et al., 1984b; Alexander et al., 1985; Dunn and Price, 1987) have demonstrated that transferring own-offspring odor to alien young via cloth stockinettes facilitates fostering in dams that have lost their young (substitution procedure). The present study extends the findings of Alexander and Stevens (1985) that the odor transfer technique may be useful for fostering additional lambs on ewes with single offspring ("add-on" procedure).

Materials and Methods

Subjects were 49 crossbred whiteface ewes of predominantly Targhee breeding ranging in age from 2 to 6 yr (X ± SE = 3.4 ± .12 yr) and 98 lambs, 86 of which were whiteface and 12 of which were blackface (derived from crossing Suffolk rams with whiteface ewes). Thirty-seven (76%) of the ewes were multiparous but only 5 (14%) had previous experience raising twins. All 49 ewes in the study gave birth to single lambs.

The study was conducted at the University of California Hopland Field Station, Hopland, California. Pre-parturient ewes were maintained in small corrals in groups of approximately 20 animals and were transferred to individual (1 x 1 m) pens within a few hours after parturition. At this time each lamb had its tail docked, was castrated (elastic bands) and was fitted with a white "Stretchtex" tubular nylon stockinette, which covered the neck, trunk, rump and tail of...
the lamb. Slits were cut on the ventral side of the stockinette for the lamb's limbs and a slit in the rear of the stockinette allowed the lamb's tail to lay under (rather than inside) the stockinette (Price et al., 1984b). The latter procedure helped to prevent feces from sticking to the lamb and stockinette, and allowed free movement of the tail. The wool condition of the lamb at the time of stockinette fitting was recorded as wet, partially wet, or dry.

Fosterings were initiated between 12 and 24 h (X ± SE = 20.4 ± .64 h) following parturition. At this time alien (add-on) lambs ranged in age from 7 to 214 h (X ± SE = 42.6 ± 6.96 h). It was not possible to match consistently own and alien (add-on) lambs by weight, but this was attempted whenever possible. Forty-six of the 49 add-on lambs were removed from ewes bearing twins; one add-on lamb was taken from a set of triplets and two add-on lambs were found abandoned in the lambing corrals.

After being selected as test subjects, ewes and their single lambs were moved from the lambing barn to one of two isolated test sites 4 km apart. At the test sites, ewe-lamb pairs were placed in 1.8- × 1.2- × 1.2-m test pens constructed with plywood (three walls) and a wire mesh divider (fourth wall) through which the ewes could see into the adjacent test pen. Next to each test pen was a solid-sided viewing booth fitted with a one-way mirror that helped conceal the human observers from the ewe and lambs being tested. The test ewe's own lambs and the alien add-on lamb were removed from their mothers approximately 3 h prior to the first acceptance test (i.e., introduction of the alien lamb) to ensure that both lambs would be motivated to interact with the dam (e.g., make suckling attempts) during the test period. During this period of separation, lambs were housed together in a 1.2- × 1.2-m enclosure in a barn out of auditory range of their own dams.

Own and alien lambs that had the same facial coloration (either both whiteface or both blackface) formed experimental group 1 (31 ewes). Experimental group 2 (10 ewes) evolved when whiteface own-lambs were paired with blackface add-on lambs. The eight control group ewes had own-lamb and add-on lamb pairs that were of the same facial coloration.

Immediately prior to the first acceptance test, one of two odor-transfer techniques was employed. In 31 cases, the stockinettes worn by own and alien (add-on) lambs were exchanged (24 of 31 lamb pairs in experimental group 1 and 7 of 10 pairs in group 2). In 10 cases, the own-lamb's stockinette was transferred to the add-on lamb; but the add-on lamb's stockinette was discarded (7 of 31 lamb pairs in experimental group 1 and 3 of 10 pairs in group 2). In the control group (eight ewes) own-lambs retained their own stockinettes (i.e., odor was not transferred).

As soon as the stockinette transfer was completed, own and add-on lambs were transported from the holding area to the test site and simultaneously presented to the test ewe. Observations began at the time of introduction; data were collected for the following 10-min period. A total of four 10-min acceptance tests, spaced 24 h apart, were conducted for each ewe-lamb test group. The first three acceptance tests were administered while the ewe-lamb test group was confined in the individual test pens. The fourth acceptance test was conducted in a small corral (5.4 × 6.1 m) in the presence of three other ewe-lamb groups. Lambs were separated from the ewe for only the 3 h prior to each acceptance test.

Behaviors recorded during each 10-min test were: 1) frequency of butts and butt attempts made by the ewe toward each of the two lambs, 2) frequency of suckling attempts (unsuccessful) made by add-on lambs, 3) frequency and duration of suckling bouts attained by add-on lambs and 4) suckling position used by add-on lambs during suckling attempts and suckling bouts. A suckling bout was considered successful if it lasted 2 s or more.

Add-on lambs were fostered out of auditory range of their own dams. In addition, add-on lambs were visually isolated from all ewes except that of their foster dam and the test ewe in the adjacent test pen.

The most frequently observed suckling position for twin lambs is one lamb nursing from each side of the ewe. Alternate positions are from the rear (one lamb suckles from the rear of the ewe while the other suckles from the side) or same side (both lambs simultaneously suckle from the same side of the ewe). Cross-suckling behavior (suckling strange ewes) was noted during the fourth acceptance test.

An alien lamb was considered accepted if the ewe allowed it to suckle for at least 20 s and if she did not direct any butts or butt attempts toward the lamb during two consecutive acceptance tests. Rejected lambs whose body condition or behavior indicated a loss of vigor were allowed to suckle their foster dam for brief periods be-
 tween acceptance tests while she was manually restrained. This procedure was used only when necessary to prevent starvation of rejected lambs.

After the last acceptance test, stockinettes were removed and lambs were paint-branded to facilitate identification. Ewes that met the acceptance criteria were placed in small (2 ha) pastures with their lambs and were observed periodically for 7 d. Ewe-lamb groups in which the add-on lamb appeared vigorous after 7 d were moved to a 25-ha pasture until weaning, approximately 5 mo later.

Behavioral data for the three treatments were analyzed using a weighted squares of means analysis, which approximates a least-squares analysis and is acceptable for complete, yet unbalanced data. Data were transformed when necessary, to conform with the assumption of variance homogeneity; natural logarithms were used for frequency data and arcsine square root for percentage data. The error term for treatments was the within-subject mean square; the error term for tests and test x treatment interaction was subject within treatment  test mean square. Following repeated measures analysis of variance, means were compared using Bonferroni t statistics (Gill, 1978).

The frequency of rear-oriented suckling attempts and bouts was compared for accepted and rejected lambs over the four acceptance tests. Chi-square probability tests were applied when appropriate (Siegel, 1956).

**Results**

Twenty-one of the 31 ewes (68%) in group 1 (both lambs same facial color) accepted an add-on alien lamb (table 1). Only 2 of 10 ewes (20%) in group 2 (whiteface-blackface pairs) and one of eight ewes (12.5%) from the control group accepted an alien lamb. The acceptance rate for group 1 was higher than for group 2 ($x^2=5.19$, df= 1, $P<.05$) and the control group ($x^2=5.81$, df= 1, $P<.02$), but adoption rates for group 2 and the control group were not significantly different ($x^2=.04$, df =1).

Ten of the 24 ewes (42%) that adopted add-on lambs did so immediately (table 1). Twenty of these 24 ewes (83%) had adopted add-on lambs by the second acceptance test or approximately 24 h after their first exposure to the alien young. The remaining four ewes that accepted add-on lambs exhibited acceptance behavior starting with the fourth acceptance test conducted in the group test pen.

The treatment x test interaction for number of butts directed toward alien lambs during acceptance tests was significant ($F=3.40$, df= 2/46). Alien lambs received more butts from ewes in the control group than from ewes in experimental group 1 during acceptance tests 1 ($P<.01$) and 2 ($P<.05$; figure 1). This difference was not significant in acceptance tests 3 and 4. Ewes in experimental group 2 did not differ significantly from control ewes or the ewes in experimental group 1 for frequency of butts directed toward alien lambs.

Treatment differences in suckling success (the frequency of suckling bouts divided by the frequency of suckling bouts plus suckling attempts) were not statistically significant ($F=.94$, df= 2/46). However, a test effect was found ($F=13.17$, df= 3/138, $P<.001$; figure 2). The suckling success of add-on lambs was lower during test 1 than during all other tests ($P<.01$, for all comparisons). The test x treatment interaction for this variable was not significant ($F=1.30$, df= 6/138).

Total number of suckling bouts made by add-on lambs did not differ for treatments ($F =

<table>
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<th>Treatment</th>
<th>N</th>
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<th>3</th>
<th>4</th>
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<td>1</td>
<td>7</td>
</tr>
<tr>
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<td>10</td>
<td>10</td>
<td>0</td>
<td>4</td>
<td>24</td>
<td>25</td>
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</tbody>
</table>

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*Acceptance criteria were actually met on the next acceptance test because acceptance had to be observed for two successive tests for adoption to be declared.

b Alien lambs paired with natural lambs of same facial coloration (white or black).

c Blackface alien lambs paired with whiteface natural lambs.
Figure 1. Mean (± SE) frequency of butts delivered to add-on lambs during acceptance tests.

Figure 2. Mean (± SE) suckling success (frequency of suckling bouts divided by the frequency of suckling bouts plus suckling attempts) for add-on lambs during acceptance tests.

1.37, df= 2/46, P>.25). However, a test effect was found (F = 15.81, df = 3/138, P<.001; table 2). Fewer suckling bouts were made by add-on lambs during test 1 than during all other tests (P<.01, for each comparison). The treatment x test interaction for this variable was not significant (F=.81, df= 6/138).

Total duration of suckling did not differ between treatment groups (F= 1.52, df= 2/46, P>.20; figure 3). A significant test effect (F= 7.30, df= 3/138) indicated that alien lambs suckled for shorter periods during test 1 than during tests 2, 3 and 4 (P<.01, for each comparison). The test x treatment interaction for suckling duration was not significant (F= 1.47, df= 6/138).

Some rejected lambs learned to get milk from their foster mothers by using the rear suckling position. More rear-oriented suckling attempts were exhibited by rejected lambs during acceptance test 4 than during acceptance tests 1, 2 and 3 (P<.001, in each comparison). This same trend was noted for successful suckling bouts (figure 4).

In group tests (fourth day), 20 of 25 (80%) rejected lambs attempted to suckle strange ewes, while only 7 of 24 (29%) accepted lambs made cross-suckling attempts. This difference was statistically significant ($\chi^2 = 12.8$, df= 1, P<.01).

A treatment x test interaction was obtained for number of butts directed toward own lambs during acceptance tests (F= 2.90, df= 6/138, P<.01). Own-lambs received more butts from ewes in group 1 than from ewes in group 2 (P<.01) and the control group (P<.1) during acceptance test 1 only (table 2). These differences were not significant in acceptance tests 2, 3 and 4.

<table>
<thead>
<tr>
<th>TABLE 2. MEAN (± SE) FREQUENCIES OF SELECTED EWE-LAMB BEHAVIORAL INTERACTIONS BY TREATMENTS AND DURING ACCEPTANCE TESTS</th>
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<tbody>
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<td><strong>Behavior</strong></td>
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<td>---------------------------------------------------------------</td>
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<tr>
<td>Suckling attempts by add-on lambs</td>
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<td>Suckling bouts by add-on lambs</td>
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<td>Butts to own lamb</td>
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Fostering success was greater for primiparous than for multiparous ewes. In group 1, seven of seven (100%) primiparous ewes adopted alien lambs, whereas only 14 of 25 (58.3%) multiparous mothers accepted add-on young. This difference was significant ($\chi^2 = 4.31$, df= 1), $P<.05$).

Age of the alien lamb at the time of fostering did not influence fostering success. Accepted aliens averaged 40.3 h, whereas rejected aliens averaged 44.7 h at the time of fostering. This difference was not significant ($F=.10$, df= 1/47).

Fostering success was not influenced by whether the alien lamb’s stockinette was discarded or transferred to the ewe’s own lamb. In group 1, 16 of 24 (66.7%) ewes accepted aliens whose stockinette had been transferred to her own lamb, whereas five of seven (71.4%) ewes accepted aliens whose stockinette had been discarded. This difference was not significant ($\chi^2=.06$, df= 1).

The condition of the own-lamb’s wool (wet vs dry) at the time the lamb was fitted with a stockinette did not influence subsequent fostering success. Ewes adopted add-on offspring in 17 of 24 (70.8%) cases where the own-lamb was wet, whereas aliens were adopted in four of seven (57.1%) cases when the own-lamb was dry at the time of stockinette fitting. This difference was not statistically significant ($\chi^2=.46$, df= 1).

Discussion

The results of this study support the conclusion that the odor transfer technique for fostering lambs facilitates adding a second lamb to dams bearing single offspring. The practical significance of this finding is meaningful only if the ewes have enough milk to support two lambs.

The relatively poor fostering success in group 2 (blackface alien lambs) confirms the importance of visual cues in offspring discrimination when odor cues are equivocal (i.e., the ewe smells own-lamb odor on both lambs). Alexander and Shillito (1977) found that black pigment applied to a lamb’s head adversely affected the dam’s responsiveness to her own lamb. The results of the present study support this conclusion and point out that it may not be practical to attempt add-on fostering when own and alien lambs differ significantly in visual appearance. Hoods placed on the heads of both lambs (Alexander et al., 1985) could possibly eliminate this problem.

If the odor-transfer technique is successful, lamb acceptance is relatively rapid. In the present study 42% of the ewes that adopted alien lambs did so immediately; 83% had adopted alien lambs by the second acceptance test, a day later. Price et al. (1984b) reported that in substituting lambs by odor transfer, 38% of the 26 ewes that accepted alien lambs did so immediately, while 85% had adopted aliens in 36 h. Alexander et al. (1985) reported that 66 or 119 (55%) ewes immediately accepted substitute alien lambs in odor-transfer trials. The four delayed acceptances in this study (fourth test) may have been facilitated by confinement (Alexander et al., 1983; Price et al., 1984a; Alexander and Bradley, 1985) because the ewes and lambs were confined to small pens for several days. The extent to which
confinement, per se, facilitated fostering in the present study was not determined.

Data in figure 1 and table 2 emphasize that the ewes in group 1 initially (test 1) exhibited rejection behaviors (butts) toward both own and alien young. In contrast, the ewes in experimental group 2 and the control treatment seldom exhibited rejection behaviors toward their own young. The aggression exhibited to both own and alien lambs in group 1 suggests that the ewes in this group were initially confused as to which lamb was their own. This phenomenon may be an important indicator that the alien lamb is likely to be adopted.

Fostering success was not significantly changed when the own-lamb did not wear the alien lamb’s jacket. This result does not agree with the findings of Alexander and Stevens (1985), but confirms the conclusion of Price et al. (1984b) that the positive influence of own-lamb odor overrides the negative influence of the alien lamb’s natural (foreign) odor. The presence of alien-lamb odor on the own-lamb (via a transferred stockinette) seldom results in its rejection. In only one fostering attempt did the dam accept the alien lamb and reject her own offspring. Alexander and Stevens (1985) reported that the frequency of own-lamb rejection was greater when own- lambs were reintroduced to their mothers 24 h after introduction of the alien young. Own-lamb rejection could be reversed by additional coat exchanges. Price et al. (1984b), likewise, indicated that a delay in own-lamb reintroduction did not improve alien lamb acceptance rates when an alien was substituted for one lamb of a set of twins.

Rejected alien lambs learned to coordinate their suckling attempts with those of the natural lamb, or developed alternative suckling positions, as did calves in work reported by Kiley-Worthington and de la Plain (1983). Rear-suckling was the most versatile alternative suckling position because it allowed the add-on lamb to avoid butts without the own-lamb’s presence at the udder. By the time of the fourth acceptance test, three of the four late-accepted add-on lambs were achieving a high percentage (69%) of their sucking bouts from the rear position. The relatively high proportion of successful rear-oriented sucking bouts by rejected lambs is illustrated in figure 4.

The fourth acceptance test in group pens facilitated identification of rejected lambs because the ewes had more freedom of movement to exhibit rejection behaviors (e.g., avoidance and butts). In addition, attempts at cross- suckling by rejected lambs was somewhat common under these circumstances.

Fostering success was greater with primiparous than multiparous ewes, a result also reported by Alexander et al. (1985). Ewes may become more adept at offspring discrimination and (or) exhibit more intense rejection behaviors after having had maternal experience.

Research identifying the limitations of the odor-transfer fostering technique would be useful to the sheep producer. Considering that add-on fostering requires an investment in labor and, if “orphan” add-on lambs are purchased, an actual monetary output, further refinement of this technique utilizing suckling position and group cross-suckling scores should provide the stockman with an important management tool.

Development of the odor-transfer fostering technique provides an excellent example of how the behavioral management of livestock can be used to improve production efficiency and profitability.

**Literature Cited**


