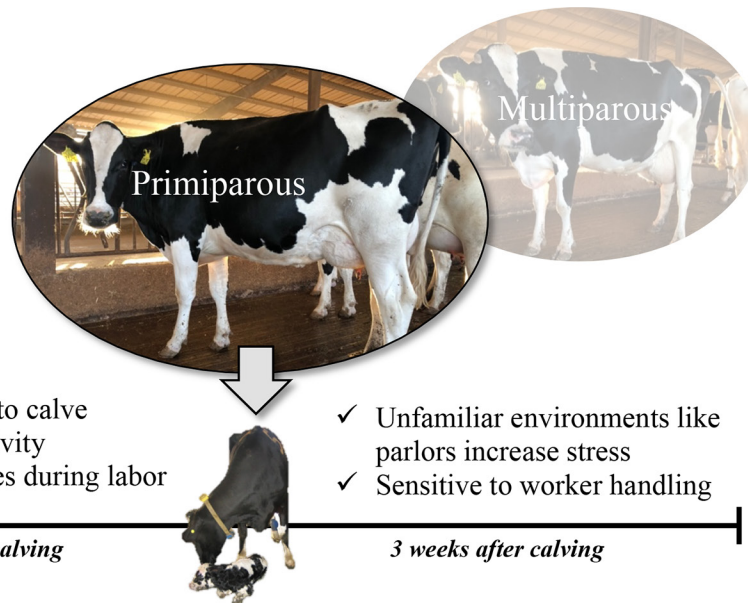


A first time for everything: The influence of parity on the behavior of transition dairy cows*

Kathryn L. Proudfoot^{1†} and Juliana M. Huzzey²

Graphical Abstract

The Primiparous Transition Cow Experience



- ✓ Seeks more distance to calve
- ✓ Increased overall activity
- ✓ More postural changes during labor

- ✓ Unfamiliar environments like parlors increase stress
- ✓ Sensitive to worker handling

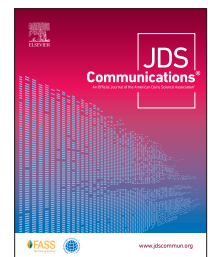
- ✓ Lower feed intake and increased standing/lying bouts
- ✓ More vulnerable to competition particularly if regrouped alone

Summary

The period from 3 wk before until 3 wk after calving is called the transition period. This is a challenging time for dairy cows due to the need to adapt, in a short period of time, to many physical and environmental changes, such as labor and delivery, the onset of lactation, pen changes, and new social groups. The primiparous cow experiences many of these changes for the very first time, and their responses to these changes differ from the older, more experienced cows. Primiparous cows show some behavioral differences from older cows only during the period before calving or after calving, while other differences span the entire length of transition. It is important to understanding the unique experiences of primiparous cows to improve the management of this vulnerable group of animals.

Highlights

- Primiparous cows face new experiences outside of their control during transition.
- Primiparous and multiparous cows have different social, feeding, and lying behaviors.
- When regrouped, primiparous cows experience more competition than older cows.
- The milking parlor elicits a stress response that negatively affects milk let down.
- Dairy producers should provide special care to primiparous cows during transition.



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A first time for everything: The influence of parity on the behavior of transition dairy cows*

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Abstract: Over the last 20 years an increasing amount of research has described how dairy cow behavior changes during the few weeks before and after parturition, also known as the transition period. Dairy cows experience several challenges during this period, including pain associated with pregnancy and labor, social stressors associated with pen moves, changes in diet, and navigating new routines that include daily milking in a parlor or automatic milking system. For cows calving for the first time (“primiparous”), these experiences may be particularly challenging compared with those animals who have calved previously (“multiparous”). The objectives of this review are to (1) summarize the research to date on behavioral differences between primiparous and multiparous animals during the transition period, (2) describe the effect of management practices, such as regrouping and milking, on primiparous animals, and (3) suggest management recommendations and future directions for research focused on the behavior of primiparous cows.

The transition period, defined as the 3 wk before to 3 wk after calving, is a difficult time for any cow to navigate, perhaps most difficult for the cow going through it for the first time. During transition, cows experience several physiological stressors (e.g., parturition, onset of lactation, changes in energy demands, and higher risk of disease; Drackley, 1999; Proudfoot and Huzzey, 2017) and social stressors (e.g., cow-calf separation, fear of novel environments such as the milk parlor, pen changes, and shifting social hierarchies; Nordlund et al., 2006; Bobić et al., 2011). For the primiparous cow giving birth for the first time, most, if not all, these changes are new, so it is not surprising that dairy producers have reported differences in their behavior compared with older cows. For example, milking primiparous cows for the first time was identified as the most challenging factor influencing optimal cattle flow on the farm according to dairy producers in Minnesota (Sorge et al., 2014), and has been identified as a main source of injuries in the parlor for New Zealand dairy farmers (Edwards and Kuhn-Sherlock, 2021). These reactions to milking are likely due to primiparous animals experiencing a combination of stressors associated with novelty, loss of control, or fear. Thus, understanding behavioral differences between primiparous and multiparous animals can provide insight into how they cope with these challenges and may ultimately help to create better environments for both the animals and the farm workers.

The aim of this review is to summarize existing literature describing the behavior of primiparous cows during the transition period. We will discuss how management changes during transition, including regrouping, co-mingling with older cows, and going to the milk parlor for the first time, uniquely affect the primiparous cow. Finally, we will end with recommendations for best practices in managing primiparous cows during transition and directions for future research. No animals were used in this review, and ethical approval for the use of animals was thus deemed unnecessary.

Researchers have identified several changes in behavior between primiparous and multiparous cows throughout transition. For example, one of the first signs of labor in cattle and other ungulates is when the dam seeks an isolated place to give birth (Lidfors et al., 1994). Researchers have speculated that this behavior may allow the dam and calf to stay hidden from predators, while at the same time giving them the opportunity to form a bond before the calf is introduced to the rest of the herd (Rørvang et al., 2018).

Primiparous dairy cattle appear to separate further than multiparous animals as calving approaches. Lidfors et al. (1994) measured the behavior of Finnish dairy cows kept in a 20-ha forest area and found that primiparous animals had a greater distance from their nearest neighbor during labor than multiparous cows. Authors speculate that the social dynamics of the herd may have influenced this behavior, as they stated that: “one of the primiparous cows started to calve in the herd but went to the forest when disturbed by other cows” (pp. 18–19). Similarly, in a study where cows were given access to a barn and a 5-acre pasture, Edwards et al. (2020) found that primiparous cows were more likely to calve in an area of pasture that was the furthest away from the barn and had some tall grass and tree cover, whereas multiparous animals were more likely to calve inside the barn. Jensen et al. (2022) also found that primiparous cows were more likely to calve further away from the feeding area of an outdoor paddock and were less likely to be approached by herd mates in the 3 h before calving compared with multiparous animals. In a study of indoor-housed cows, Creutzinger et al. (2021a) found that primiparous cows spent more time further away from other cows in the 4 h before calving compared with multiparous cows. These studies indicate that primiparous animals seem to have a stronger motivation to seek separation from groupmates at calving, which may be influenced by their social status within the group.

Detailed behaviors during labor have also been found to differ between indoor-housed cows of different parity. For example, Mi-

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edema et al. (2011) found that primiparous animals were observed raising their tails 2 h earlier than multiparous cows (e.g., 4 vs. 2 h before calving). When behavior was recorded in relation to signs of labor, Schuenemann et al. (2011) found that multiparous animals laid down at the onset of abdominal contractions and remained recumbent until birth, whereas primiparous animals showed restless behavior characterized by increased lying bouts at the beginning of labor. Although the same authors (Schuenemann et al., 2011) found no difference in the overall length of labor for primiparous and multiparous animals, other have found that primiparous animals have longer labors (e.g., 25 min longer for Creutzinger et al., 2021b and 21 min for Miedema et al., 2011).

Research using indoor-housed dairy cows has also provided evidence that social behaviors differ between primiparous and multiparous animals during transition. For example, Neave et al. (2017) measured the social behavior of cows when feeding at electronic bins from 2 wk before to 3 wk after calving and found that primiparous animals were more likely to be “replaced” (another cow physically contacted her and took her place at the bin) than multiparous cows, especially during the 3 wk before calving. Similarly, Foris et al. (2020) found that primiparous animals tended to show more signs of “competitiveness” (estimated using a combination of feeding behaviors and both actor and reactor replacements at the feed bunk) during the week before calving compared with older animals; authors speculate this to be driven by primiparous cows experiencing more reactor replacements due to their low social status in the group. Primiparous cows are likely lower in social status compared with multiparous animals as they are younger and smaller and may still be learning how to interpret and respond to aggressive social interactions from older animals.

Feeding behavior has also been shown to differ between primiparous and multiparous cows during transition. Several studies have found that primiparous animals eat less than multiparous animals before and after calving (e.g., Moore and Mao, 1990; Proudfoot et al., 2009), and some authors have suggested that BW and milk production may be factors driving this difference (Moore and Mao, 1990). However, Neave et al. (2017) accounted for BW and milk production in their models and found that primiparous animals still ate less than multiparous animals throughout transition, especially during the 3 wk after calving. In the same study, primiparous animals were also found to eat slower and visit more feed bins than older animals both during the 2 wk before and 3 wk after calving, although these behaviors were found to be driven by BW and milk production. Authors speculate that multiparous animals with larger BW and lactation demands may be eating faster to help meet these demands. Primiparous cows may also be eating slower as they learn how to consume their new feed or may be choosing to avoid eating during peak feeding times when competition for feed is greatest.

Primiparous cows and multiparous cows also have different lying behavior and activity during transition. For example, Neave et al. (2017) found that primiparous animals had more frequent transitions from standing to lying (“lying bouts”) throughout the transition period, especially in the 3 wk after calving, although on the day of calving both primiparous and multiparous cows increase their lying bouts, number of steps, and decrease their lying time compared with previous days (Huzzey et al., 2005). The duration of lying bouts (amount of time spent lying per bout) were shorter for primiparous animals, declining from 2 before to 3 wk after

calving, whereas multiparous animals had consistent lying bout durations across the period except for a decline at calving. During the 4 d before calving, primiparous animals lay down for less time, have more postural changes, and take more steps compared with multiparous cows (Barraclough et al., 2020). Similarly, Creutzinger et al. (2021a) found that primiparous cows performed more locomotor behavior during the 24 h before calving compared with multiparous cows. It is unclear whether social dynamics are driving these differences in lying bouts and activity throughout the transition period; however, increased activity in the period before calving may be caused by primiparous cows seeking a separated area to give birth.

During the transition period, both primiparous and multiparous cows must adapt to a variety of management changes. Here we will describe the effect of management and housing on primiparous and multiparous cow behavior. The first change that a dairy cow will experience on many farms as she enters the transition period is a regrouping from the far-off dry pen into the close-up pen at about 2 to 3 wk before her expected calving date. On some farms, cows will calve in this close-up pen, whereas on other farms they will be moved into a separate calving pen when they display signs of labor, typically within 24 h of parturition (Proudfoot et al., 2013). During the first 3 wk after calving, regrouping protocols vary substantially by farm. For example, cows sometimes have a short stay in a hospital/colostrum pen (0–3 DIM) or a “fresh” cow pen (3–14 DIM), followed by the final move into the lactation pen (Nordlund et al., 2006). Therefore, it is possible that a dairy cow may experience up to 5 regroupings over the course of a 6-wk transition period.

When cows are regrouped into a new pen alone, they are more vulnerable to competition (i.e., are displaced from resources such as the feed bunk more often) by the current resident cows in the pen (von Keyserlingk et al., 2008). Increased competition due to regrouping occurs as cows attempt to re-establish a stable social hierarchy (Kondo and Hurnik, 1990). In competitive environments, primiparous cows are more likely to be low in the social hierarchy and thus more often be the reactor during competitive displacements or replacements. Consequently, primiparous cows who are moved into the lactation pen for the first time may have more difficulties adapting to this transition than multiparous cows. For example, Mazer et al. (2020) measured fecal cortisol metabolites (11,17-dioxoandrosterone), a noninvasive physiological marker of stress (Palme, 2019), among cows regrouped individually or with a partner at 3 DIM. Among cows moved alone, primiparous animals had higher fecal cortisol metabolites during the first 4 d after regrouping compared with multiparous cows. Moreover, primiparous cows that were moved with a partner had lower fecal cortisol metabolites than those cows moved alone (Mazer et al., 2020).

Moving into a new pen with a familiar partner may provide primiparous cows with social support that could protect them from competitive interactions with unfamiliar cows. Indeed, research has shown that familiar cows stick close to one another when regrouped together. For example, O’Connell et al. (2008) reported that when primiparous cows were housed with a partner for 7 d before being regrouped at 7 DIM, they spent more time together than expected in the same areas of the pen during the first 8 h after regrouping and spent more time than expected in adjacent lying stalls over the month following regrouping. This companionship may be comforting and allow cows to settle more quickly after

regrouping. O'Connell et al. (2008) found that regardless of the day that primiparous cows were moved (1 or 7 DIM), if they were moved alone, they tended to spend more time standing during the first 8 h following regrouping when most of the other cows in the group were resting, compared with primiparous cows moved with a familiar partner.

The timing of regrouping has also been shown to influence primiparous cow behavior. For example, Boyle et al. (2012) reported that when primiparous cows were moved into the postpartum pen following the morning milking they spent more time at the feed bunk but were also the recipients of more threats, chases, and head butts compared with primiparous cows moved in the evening. Primiparous cows also engaged in more social licking and head rubbing during the period following feeding if moved in the evening (Boyle et al., 2012); these behaviors are a sign of affiliative behavior which is important for the development of positive social bonds (Rault, 2012).

For primiparous cows, regrouping during the transition period will at some point involve moving into a pen with multiparous cows ("co-mingling") for the first time. Co-mingling often occurs during the few weeks before a primiparous cow's first calving; however, some producers wait until late lactation or the second lactation before mixing them with older cows. When primiparous cows were moved to a pen with only other primiparous cows, they spent more time eating and tended to spend more time lying compared with primiparous cows mixed with multiparous cows after calving (Krohn and Konggaard, 1979). Boyle et al. (2013) investigated the effects of co-mingling cows before calving on behavior during the 2 h after regrouping into a co-mingled postpartum pen. Primiparous cows in the mixed parity group before calving had higher activity and experienced fewer head butts following regrouping compared with cows that were not co-mingled before calving. Primiparous cows in the mixed prepartum pen also spent less time in the lying stalls and more time in the area beside the feed bunk 2 h after regrouping. Authors speculated that the social experience of primiparous cows in a co-mingled prepartum pen allowed them to better adapt to the new conditions of the postpartum pen.

Another challenge for primiparous cows during transition is experiencing the milk parlor for the first time. Milking includes exposure to an unfamiliar environment, which has been found to inhibit oxytocin release and milk letdown (reviewed in Bobić et al., 2011); however, individual variation among primiparous cows exists in this response, with not all individuals being affected equally (VanReenen et al., 2002). During milking, it is normal for plasma cortisol to increase over the course of the milk let down; however, when cows are milked in an unfamiliar environment, cortisol levels at the start of milking have been shown to be double that of cows beginning milking in a familiar environment (Bruckmaier et al., 1993). For primiparous cows, stress from being milked might also be coupled with stress associated with rough handling by workers frustrated by the challenges of moving reluctant animals into the parlor or into headlocks for breeding or treatment. Rushen et al. (1999) reported that cows who were handled aversively during the day kicked more for the duration of milking, moved more during milking, had a greater increase in heart rate during milking and had on average 1.5 kg more residual milk following milking compared with cows handled calmly.

It is clear from the literature reviewed thus far that several behavioral differences exist between primiparous and multiparous cows throughout the transition period, including when they are exposed to management changes such as regrouping or milking. Here we provide recommendations for how dairy producers can manage their primiparous animals to mitigate stress during this vulnerable period. First, we suggest that all cows be provided with the opportunity to seek a secluded place to give birth (e.g., Rørvang et al., 2018). However, we also recommend that special care be given so that primiparous cows have the space needed to separate from other cows when they are expected to give birth. For example, producers are recommended to either move primiparous animals to individual calving pens in advance of calving or provide space and visual separation if kept in group calving pens (e.g., Creutzinger et al., 2021a,b).

Second, we recommend that pens are not overstocked during the transition period, as overstocking can increase competition (Cook, 2019), which may be particularly stressful to low status primiparous animals. If possible, we suggest that primiparous animals be kept in pens with their peers (e.g., other primiparous animals) throughout their first transition period to additionally reduce competition (e.g., Eriksson et al., 2021). If this is not possible, it is recommended that primiparous animals not be moved in with older cows immediately after calving. Third, it is recommended that regrouping be limited throughout the transition period, and, if possible, cows be kept in stable all-in-all-out groups (Cook, 2019). If primiparous animals must be moved into a new group, we suggest that producers move them with at least one familiar partner (e.g., Mazer et al., 2020). To further reduce competition after regrouping, we also recommend that primiparous cows be moved into low-stocked rather than high-stocked pens throughout the transition period (e.g., Eriksson et al., 2021).

Future research is encouraged to develop practical methods to better prepare primiparous animals for transition. For example, researchers have found that heifers trained to using a milking parlor before calving show less stepping and kicking during udder preparation as well as a lower likelihood of putting their ears flat on their heads, clamping their tails between their legs, and having their eyes wide open throughout milking compared with untrained heifers (Kutzer et al., 2015). Introducing heifers to a "phantom" automatic milking system (e.g., a similar system without the technical equipment needed for milking) has also been shown to increase the number of visits primiparous animals make to the real automatic milking system postcalving and reduce the need for fetching (von Kuhlberg et al., 2021).

Research is also needed to understand how to give primiparous cows more control over their experience throughout transition. It has been argued that the amount of control an animal experiences is directly linked to their experience of stress, where the more uncontrollable environments lead to animals experiencing a higher amount of stress (Koolhaas et al., 1999). Moreover, animal welfare researchers are also recommending that animals be provided more "agency" (reviewed by Špinka, 2019). For example, Lomb et al. (2021) gradually trained young heifers to voluntarily place their head in a headlock to receive an injection using grain as a reinforcer. Trained "agency" heifers showed a lower latency to enter the headlock compared with habituated (e.g., introduced to the headlock but not given a reward) and naive (e.g., no exposure to

the headlock) animals. We recommend that a similar idea be applied to primiparous animals during transition.

More research is also encouraged to better understand social cognition during the transition period, including the role of social support in buffering stressors. Social support has been well documented in cattle and other farm species to help mitigate a wide variety of stressors (reviewed by Rault, 2012), but less focus has been given to primiparous animals during the transition period. Keeping cohorts of young animals together during this challenging time may help buffer some inevitable stressors (e.g., regrouping; Mazer et al., 2020). Thus, we recommend that researchers develop a stronger understanding of social recognition (e.g., Boyle et al., 2013), which animals provide the best social support, and how best to provide opportunities for primiparous animals to benefit from each other.

During their first transition, primiparous dairy cows face several new experiences that are outside of their control and that, in many cases, they face alone. Researchers have found that primiparous animals behave differently than multiparous animals throughout transition and may be more susceptible to stressors due to management changes such as regrouping. Thus, we suggest that future research focus on the perspective of the primiparous animals, including ways to help better prepare them for the challenges they will inevitably face, give them some control over their own experiences, and provide them with social support.

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Notes

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