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No effects of tactile stimulation on welfare indicators of Saanen goat kids: a pilot study

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ABSTRACT. This study aimed to evaluate the effects of tactile stimulation on the welfare of goat kids. Thirty-six goat kids were allocated into three treatments as follows: TSG = taking the goat kids out of the cage every day when they received tactile stimulation, RCG = taking the goat kids out of the cage for 5 s, and NRS = not taking the goat kids out of the cage nor receiving tactile stimulation. TSG goat kids received tactile stimulation once a day, for two minutes, from the 3rd to the 40th day. Goat kids' welfare was assessed by considering performance, health, and behavioral indicators. During the voluntary approach test, 96.5% of the goat kids voluntarily approached familiar and unfamiliar humans. There were significant effects only on the interaction between treatment and age on time spent in the corners and time playing (KW = 27.54 and 47.83, $p < 0.01$, respectively). We conclude that tactile stimulation did not affect any of the welfare indicators addressed in this study.

Keywords: human-animal interactions; performance; health; behavior.

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Introduction

Experience plays a relevant role in modulating behavior and is most marked when it occurs in early life (Fernándes-Teruel et al., 2002; Wiedenmayer, 2010). For example, promoting tactile stimulation, brushing, or other positive contact during the first days of livestock reduces fear and reactivity to handling in the future (Sato, Shiki, & Yamazaki, 1984; Boivin & Braastad, 1996; Lansade, Bertrand, & Bouissou, 2005; Oliveira, Costa, Zupan, Rehn, & Keeling, 2015), and has a positive effect on health (Silva-Antunes & Costa, 2021), improving the overall welfare state of these animals (Lensink, Boivin, Pradel, Le Neindre, & Veissier, 2000a; Lensink at al., 2000b; Lange et al., 2020).

Many studies have reported positive changes in livestock behavior when subjected to tactile stimulation in early life, as described for piglets (Oliveira et al., 2015), lambs (Boivin, Tournadre, & Le Neindre, 2000; Coulon et al., 2013; 2015), and heifers (Lürzel, Windschnurer, Futschik, Palme, & Waiblinger, 2016). For example, Silva, Sant'Anna, Silva, and Costa (2017) observed that the adoption of good handling practices, including tactile stimulation, during the pre-weaning period of dairy calves had long-term positive effects on their behavior, reducing their reactivity and facilitating handling.

It should be taken into account that tactile stimulation promotes more changes than just modulating behavior since it also has the potential to speed brain development by increasing dendritic branching, dendritic length and spine density, resulting in a more complex neural network (Richards, Mychasiuk, Kolb, & Gibb, 2012; Mychasiuk, Gibb, & Kolb, 2013), attenuate stress (Moyer-Mileur et al., 2011), and boost immune response (Major et al., 2015); furthermore, by mimicking the social licking, it grants positive sensations to the tactile stimulated animals (Schanberg & Field, 1987; Nakamura & Sakai, 2014).

However, regardless of the species, it should be considered that individuals can react in different ways when subjected to tactile stimulation, as described for foals (Henry, Richard-Yris, & Hausberger, 2006) and piglets (Oliveira, Keeling, & Costa, 2019). This individual variation probably results from the combined action of internal and external factors, which modulate the reaction of animals to a specific stimulus, such as motivation, affective states, and previously established relationships (Waiblinger, 2017).

Thus, it is essential to consider that the individual responses to tactile stimulation are not always positive, as some animals did not show any change in their behavior while others became more reactive after being exposed to repeated sessions of tactile stimulation, characterizing a process of behavioral sensitization (Oliveira et al., 2019), defined as an increase in excitability resulting from repeated exposure to a stimulus (Çevik, 2014). Therefore, it is necessary to acknowledge the role of individual differences in animal reactions to tactile stimulation.

As far as we know, only two studies have addressed the effects of tactile stimulation in goats, both carried out in adult animals (Jackson & Hackett, 2007; Leite et al., 2020), and their results are in line with the outcomes obtained with other species, indicating that goats that received tactile stimulation were less stressed and showed faster habituation to human presence, resulting in more positive interactions with humans, which lead us to hypothesize that tactile stimulation improves goat kids welfare. This study aimed to evaluate the effects of tactile stimulation on the welfare of Saanen goat kids.

Material and methods

The Committee of the Ethical Use of Animals of the Faculty of Agricultural and Veterinary Sciences, São Paulo State University, Jaboticabal, São Paulo State, Brazil, approved this study (protocol n. 006613/14). Data collection was carried out in the same institution, at the Goat Teaching & Research Facilities, with 36 Saanen goat kids (12 males and 24 females), all born by natural delivery without assistance and weighing at least 2 kg at birth.

Soon after birth, goat kids were separated from their mothers, identified with numbered collars, weighed, and had their navels disinfected by dipping them into 10% iodine solution. At the end of these procedures, the goat kids were housed in a shed, keeping them in groups of four, accommodated in cages measuring 1.50 x 1.02 m and fixed 1.00 m from the shed floor.

On the first day of kids' lives, they were bottle-fed with good-quality bovine colostrum (assessed with a colostrometer, Biogenics, Florence, OR, USA) ad libitum. From the 2nd to the 15th day of life, they were fed 1000 mL day^{-1} of fresh cow's milk, delivered in buckets with nipples, and divided into two meals (offered around 06:00 and 17:00 hour). From the 16th to 45th day of age, the total amount of milk increased to 1400 mL day^{-1}, and from the 46th to the 60th day of life, they were milk-fed only in the afternoon, receiving 700 mL of milk. The temperatures of colostrum and milk offered to the kids were always between 36.0 and 37.5°C. Goat kids were milk-fed with cow colostrum and milk to reduce the risk of Caprine Arthritis Encephalitis (CAE) infection.

During the entire milk-feeding period, goat kids had free access to water, concentrate (composed of 54.8 corn, 10 soybean, 4 wheat bran, 15 soybean meal, 10 cottonseed meal, 4.2 milk and 2% calcitic limestone) and Tifton 85 hay (*Cynodon nlemfuensis*).

Experimental procedures

The Goat kids were randomly assigned to one of three treatments, balanced by birth order and weight, as follows: 1) TSG = taking the kids out of the cage every day after morning milk feeding and tactile stimulation for two minutes (n = 12) from the 3rd to the 40^{t}h day of age; 2) RCG = removing the kids from the cages for 5 s and putting them back (n = 12, control purposes); and 3) NRS = maintaining the kids inside the cages throughout the experimental period, with no removal or tactile stimulation (n = 12). The same person was responsible for carrying out all kids' handling procedures.

Welfare indicators

Performance indicators

The weights of goat kids were recorded at birth (BW0) and every 15 days until they reached 60 days of age (BW15, BW30, BW45 and BW60, respectively). Based on that, we calculated the average daily gains of each kid for every 15 days from birth to 60 days of age (ADG0-15, ADG0-30, ADG0-45, and ADG0-60, respectively).

Health indicators

Health indicators were assessed using a binomial scale, by recording the absence (0) or occurrence (1) of death, signs of ocular (OD) and nasal discharges (ND), and diarrhea (DIA, defined by the presence of pasty or liquid feces), recorded daily from birth until goat kids reached 30 days of age. The number of deaths, if any, was also recorded.

Behavioral indicators

The open field tests (OFT; adapted from Oliveira et al., 2015) and the voluntary approach (adapted from Jago, Krohn, & Matthews, 1999) were performed every 15 days from the 30th until the 60th day of age (at weaning), and were always carried out on two consecutive days (Saturdays and Sundays), after morning milk feeding. Each test lasted for 120 s, which was divided by two (60 s) when running the VAT with an unfamiliar and familiar person. First, the OFT was performed by positioning the kids (one at a time and by a familiar person) in the middle of a room (9.6 m^2) and recording the following variables of their behavior: vocalization frequency (VOC), time attempting to escape (TAE, measuring the time each kid placed its two front hooves on the door of the testing room, maintaining a bipedal posture), time spent in the corners (TSC, time spent by each kid resting theirs body on the corners of the room, regardless of the corner) and playing time (PLAY, time that each individual spent running or jumping inside the room).

AT was performed immediately after the OFT, with an unfamiliar and familiar person entering the test room on Saturdays and Sundays, respectively, positioning themselves (in silence and without sudden movements or maintaining eye contact with the goat kids) in the center of the test room. The latencies of each goat kid approaching the unfamiliar (LATuf) and familiar person (LATf) were recorded, as well as the respective frequencies of vocalization (VOCuf and VOCf). The maximum time (60 s) was recorded when the goat kids did not approach an unfamiliar or familiar person.

The behaviors of the goat kids were video-recorded (Sony®, Full HD Digital, CX405) during the OFT and VAT. The camera was strategically positioned in the test room to cover the entire space of the goat kids. A previously trained researcher watched the videos without knowing the treatment applied to each goat kid.

Statistical analyses

Statistical analyses were performed using R software with the RStudio integrated development environment (R version 4.1.3 (2022-03-10, RStudio, Inc.). Differences were considered statistically significant at $p < 0.05$. The best fit for the adopted models was performed with the 'step-up' procedure by receiving Akaike (AIC) and Bayesian information (BIC). The Shapiro-Wilk test was used to test the normality of the residual errors in the adopted models. Outliers were identified and conserved in the data analyses because they were products of individual variations within the species.

The performance variables were analyzed using mixed linear models ('lme4', Bates, Maechler, Bolker, & Walker, 2015), considering the fixed effects of treatment (TSG, RCG, and NRS), gender (male and female), age (15, 30, 45, and 60 days) and the interaction between them. Birth weight was included as a covariate and animal weight as a random effect.

VOC and TAE required a square-root transformation to meet the assumptions of a normal distribution of residuals. They were analyzed using linear models of mixed effects, considering the fixed effects of treatment (TSG, RCG and NRS), gender (male and female), and days of age (15, 30, 45, and 60 days), as well as the interaction between them as fixed effects, and animal as a random effect. Multiple comparisons were performed using the Tukey's test to compare the adjusted means between treatments for each day of age. To illustrate the results of these comparisons of the analyzed variables, box plots (ggplot2) were constructed according to the case.

The non-parametric Kruskal-Wallis's test was used for TCO, PLAY, LATf, VOCf, LATuf, and VOCuf data analyzes, complemented by Dunn's test with Bonferroni correction, for post-hoc comparisons.

No statistical analyses were carried out with health indicators because none of the kids died, and only a small number of animals showed clinical signs of DIA, ND, and OD, resulting in a high frequency of zeros.

Results and discussion

Performance indicators

The BW and ADG of goat kids were significantly affected ($p < 0.05$) by age and gender but not by treatment ($p > 0.05$). There was also no significant effect ($p > 0.05$) of the interactions between treatments and the age and gender of goat kids (Table 1).

Table 1. Means ± standard errors of body weight (BW, kg) and average daily gain (ADG, kg day^{-1}) of goat kids (n = 36) according to the treatments (TSG = taking the kids out of the cage every day after morning milk feeding and tactile stimulation for two minutes; RCG = removing the kids from the cages for 5 s and putting them back; and NRS = maintaining the kids inside the cages throughout the experimental period, with no removal or tactile stimulation), and goat kids gender (females and males) and age (15, 30, 45 and 60 days). Lowercase letters indicate significant differences (p < 0.05).

Sources of variation	BW	ADG
Treatment		
TSG	7.78 ± 0.25	0.11 ± 0.007
RCG	7.41 ± 0.23	0.11 ± 0.006
NRS	7.70 ± 0.22	0.12 ± 0.006
Gender		
Female	7.33 ± 0.15b	0.11 ± 0.004
Male	7.94 ± 0.23a	0.12 ± 0.006
Age (days)		
15	4.43 ± 0.16d	0.09 ± 0.004c
30	6.40 ± 0.16c	0.11 ± 0.004b
45	9.08 ± 0.16b	0.12 ± 0.004a
60	10.62 ± 0.16a	0.13 ± 0.004a

Health indicators

No deaths occurred during the study. The daily records of the clinical signs of disease (DIA, OD, and ND) over a period of 30 days are shown in Table 2.

Table 2. Number of days of occurrence of clinical signs of diarrhea (DIA), ocular (OD), and nasal discharge (ND) according to the treatments (TSG = taking the goat kids out of the cage every day after morning milk feeding when they received tactile stimulation, RCG = taking the goat kids out of the cage for 5 s and putting them back, and NRS = not taking the goat kids out of the cage or receiving tactile stimulation).

Treatment	Clinical signs of disease (number of days)		
	DIA	OD	ND
TSG	2	4	4
RCG	5	5	11
NRS	3	1	0

Behavioral indicators

There was a significant effect of age on VOC and TAE (p < 0.05), with a higher frequency of VOC when they were 15 days old compared to the older kids and, on the way around, with older kids showing longer TAE than younger ones. No effects (p > 0.05) of treatment, gender, or the interaction between treatment, gender and age were observed on the behavioral indicators (Table 3).

Table 3. Means ± standard error of vocalizations (VOC) and time attempting to escape from the room (TAE, s) according to the treatments (TSG = taking the goat kids out of the cage every day after morning milk feeding when they received tactile stimulation, RCG = taking the goat kids out of the cage for 5 s and putting them back, and NRS = not taking the goat kids out of the cage nor receiving tactile stimulation), and goat kids gender (females and males), and age (15, 30, 45, and 60 days). Lower-case letters indicate significant differences (p < 0.05).

Sources of variation	VOC (frequency)	TAE (s)
Treatment		
TSG	21.4 ± 4.09	4.24 ± 1.02
RCG	21.3 ± 3.70	3.90 ± 0.91
NRS	28.9 ± 0.352	2.82 ± 0.87
Gender		
Female	23.8 ± 2.50	2.63 ± 0.62
Male	24.0 ± 3.58	4.68 ± 0.88
Age (days)		
15	49.0 ± 3.14a	0.65 ± 0.88c
30	20.3 ± 2.98b	1.62 ± 0.81c
45	14.5 ± 2.98b	4.26 ±.081b
60	11.9 ± 3.03b	8.08 ± 0.83a

Significant effects (p < 0.05) of the interaction between treatment and age were observed for TCO (KW = 27.54, Figure 1a) and PLAY (KW = 47.83, Figure 1b). LATf, VOCf, LATuf, and VOCuf did not differ between treatments, gender, or age (p > 0.05).

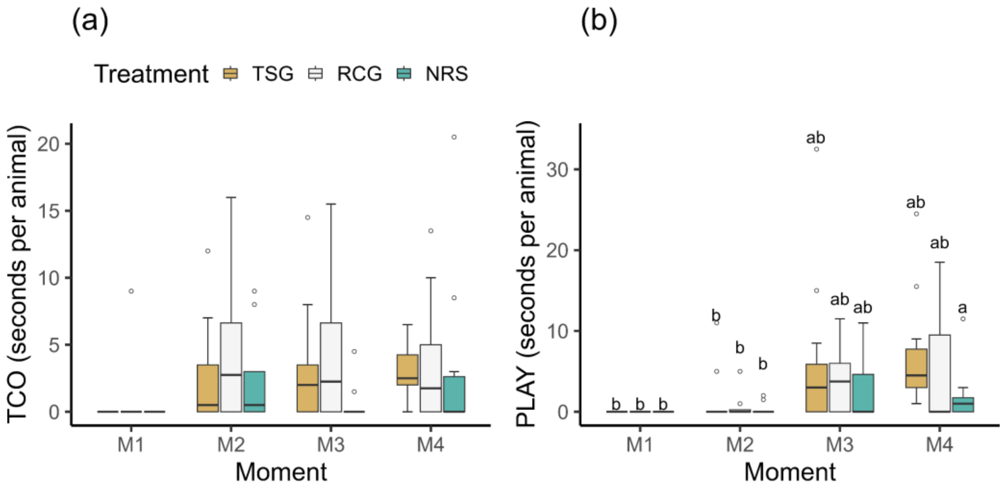

Figure 1. Box plots of (a) the time spent by each goat kid in the corners of the test room (TOC) and (b) time spent playing (PLAY) according to the treatments TSG = taking the kids out of the cage every day after morning milk feeding and tactile stimulating them for two minutes; RCG = removing the kids from the cages for 5 s and putting them back; and NRS = maintaining the kids inside the cages throughout the experimental period, with no removal or tactile stimulation), and goat kids age (15, 30, 45, and 60 days). The line within the box represents the median and the circles represent the outliers.

Contrary to our hypothesis, the tactile stimulation did not have a positive effect on the welfare indicators evaluated in this study. A possible explanation for this result is that all kids experienced intense visual, auditory, and olfactory stimuli and were milk-fed twice daily, regardless of treatment. Furthermore, some kids reacted in a particular way when subjected to tactile stimulation, while others tried to lightly bite the person responsible for the tactile stimulation, while others tried to escape. These reactions probably indicate that they felt uncomfortable when subjected to tactile stimulation. Individual differences in how goats react to human physical contact have been reported by Leite et al. (2020). In an experiment carried out with nanny goats, the authors described that some of them took a long time to touch and massage, while others did not. According to the authors, such reactions could result from previous interactions of these animals with humans, which may have harmed them. However, this was not the case in our study, as the kids had no previous experience with humans.

Additionally, it is well known that animals establish intra and interspecific social communication through visual, acoustic, olfactory, gustatory and tactile interactions (Immelmann, 1980). For instance, Malsche and Cornips (2021) reported that positive social contact between humans and goats occurs when goats are fed by humans, when humans smoothly talk to them, or when they play with humans nibbling their clothes. Such reports support the assumption that goat kids establish positive contact with humans in different ways, in addition to tactile stimulation.

Performance indicators

Similarly, we did not observe any effect of tactile stimulation on the BW and ADG of goat kids. These results agree with the results of previous studies on dairy calves (Lensink et al., 2000b), lambs (Pascual-Alonso et al., 2015) and piglets (Muns, Rault, & Hemsworth, 2015). However, they disagree with the results of studies showing a positive effect of tactile stimulation on the performance of piglets (Oliveira et al., 2015), dairy calves (Lürzel, Windschnurer, Futschik, Palme, & Waiblinger, 2015), rodents (Weininger, McClelland, & Arima, 1954; Levine, 1960) and humans (Field et al., 1986; Caulfield, 2000; Feldman, Singer, & Zagoory, 2010). Furthermore, previous studies have shown that goats with little contact with humans show impaired alveolar milk ejection and, consequently, a reduction in milk production (Lyons, 1989). Similarly, Sevi, Casamassima, Pulina, and Pazzona (2009) reported that fear of humans negatively affects milk production in sheep and goats, and Miller et al. (2018) observed higher weight gain in feral goats kept in captivity when they had a greater possibility of contact with humans.

Although we did not observe any significant effects of treatment on BW and ADG during the milk-feeding period, we cannot ignore its potential long-term effects, creating opportunities for future studies addressing the effects of early tactile stimulation on the performance of goat kids after weaning.

Health indicators

It is well known that the neonatal period is critical for the goat industry, as most goat kids' deaths occur within the first month of life (Balasopoulou, Kalić, Zablotski, Zerbe, & Voigt, 2022). None of our goat kids died, and there were few of days occurrence (TSG = 10, RCG = 22, and NRS = 4) when they showed clinical signs of all diseases. Such good results are probably due to the good practices of the management adopted.

It has been reported that stockmanship competence (Alcedo, Ito, & Maeda, 2015) and the exposure of animals to positive human-animal interactions promote their health. For example, resistance to diseases can be improved by boosting the immune response of young animals that are tactile-stimulated, as reported for lambs (Caroprese et al., 2006) and rat pups (Levine, Haltmeyer, Karas, & Denenberg, 1967; Van Oers, Kloet, & Levine, 1998; Levine, 2001). Thus, gentle treatments should be adopted during veterinary practices, such as “[...] deworming and attending to animal's needs when sick, gestating and kidding [...]” (Alcedo et al., 2015, p. 432-433) to ensure better health and performance, as demonstrated by Napolitano et al. (2006), who reported a reduction in the plasma cortisol response and positive effects on lamb meat pH and tenderness.

It is worth mentioning that, from a practical point of view, the lower incidence of diseases brings positive ethical and economic aspects because such conditions contribute to the promotion of animal welfare and reduce the expenses of veterinary services and medicines (Torsein et al., 2011; Meganck, Hoflack, Piepers, & Opsomer, 2015). Additionally, tactile stimulation enables closer proximity between workers and animals, facilitating the identification of clinical signs of diseases, which increases the probability of initiating early treatment and, consequently, improves the chances of a cure.

Behavioral indicators

No effect of tactile stimulation was observed on the behavioral indicators. However, there were significant effects of the interactions between VOC and TAE on age. An inversely proportional relationship was observed between VOC and age, with an expressive reduction in VOC after the 30th day of age, regardless of the treatment. On the other hand, the relationship between TAE and age was directly proportional, with a considerable increase in TAE across the ages of goat kids. These changes most likely occurred because we conducted the behavioral tests in the same room. Thus, over time, the kids probably got used to the room, vocalizing less and spending more time trying to escape.

Goat kids showed TCO and PLAY behaviors only in the second and third tests, when they were 30th and 45th day of age, respectively. We speculate that the expression of such behaviors could be related to the animal's experience, considering that when they get used to the room and feel more comfortable, there is a higher probability of showing exploratory behavior, spending more time in the corners, and performing play behavior for a longer time.

Regarding the other behavioral variables (LATf, VOCf, LATuf, and VOCuf), the assumption that tactile-stimulated goat kids would show fewer fear reactions and a faster approach to humans than non-stimulated ones, was not confirmed. According to Waiblinger et al. (2006), fear reactions can result from three challenging situations, social separation, new environment, and human presence. In our study, all kids were exposed to visual, auditory, and olfactory stimuli of many people from birth to weaning, which likely habituated them to the people.

Therefore, under the conditions of the present study, regardless of the treatment tested, it is likely that the goats did not fear humans, nor did the environment and handling procedures challenged them. These conditions may have resulted from the set of interactions, in addition to tactile stimulation, to which the kids were exposed. This interpretation agrees with Hemsworth, Coleman, Barnett, Borg, and Dowling (2002), who stated that non-tactile interactions can also positively influence the lives of animals.

In a more recent study, Mastellone et al. (2020) observed that when subjected to challenging task tests, goats with a long history of socialization (e.g., in the presence of visitors almost daily) had a higher number of visual, tactile, and approach behaviors directed towards humans when compared to those used only for simple routine care by the handler. Additionally, Miller et al. (2018) demonstrated that more frequent interactions with humans (characterized by humans entering the goat enclosure daily and walking calmly) favored the adaptation of feral goats from pastures to intensive rearing systems.

Our results corroborate those of Lürzel et al. (2015), who observed few behavioral differences between treatments resulting from good interactions between humans and calves. Similarly, Leite et al. (2020) did not observe differences in the voluntary approach of goats to humans resulting from tactile stimulation. On the other hand, Jackson and Hackett (2007) observed that tactile-stimulated goats approached humans faster than non-stimulated ones, and Muns et al. (2015) and Oliveira et al. (2015) also reported a positive effect of tactile, auditory, and visual stimuli on the behavior of piglets.

It is worth mentioning that flight distances were not measured after the voluntary approach test because almost all goats (96.5%) voluntarily approached humans (unknown and familiar). Therefore, this result also supports the hypothesis that the stimuli present in routine handling strengthens the positive interaction between kids and humans, regardless of treatment.

Conclusion

We conclude that tactile stimulation did not affect the performance, health, or behavior of goat kids. However, it is essential to consider that all goat kids showed high performance, good health, and appropriate behavior, indicating that they were under great care and had a high standard of animal welfare. As shown by the survivability, the low occurrence of clinical signs of diseases and the expression of behaviors indicated a positive interaction with humans.

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