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Behavioral analysis of preterm neonates included in a tactile and kinesthetic stimulation program during hospitalization

Análise comportamental de recém-nascidos pré-termos incluídos em um programa de estimulação tátil-cinestésica durante a internação hospitalar

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Abstract

Objective: To evaluate the effect of tactile and kinesthetic stimulation on behavioral and clinical development in preterm neonates while still in the hospital. Methods: Thirty-two clinically stable preterm infants weighing <2500 grams, with no significant perinatal asphyxia, were allocated to two groups: a control group (CG) in which no intervention was made (n=16) and a study group (SG) in which the newborn infants received tactile and kinesthetic stimulation (n=16). Data on the infants' clinical progress were collected from medical charts and behavioral evaluations by means of a series of weekly, eight-minute films recorded from the time of inclusion into the study until hospital discharge. Results: There was a trend towards a shorter duration of hospital stay, increased daily weight gain and a predominance of self-regulated behavior (regular breathing, state of alertness, balanced tonus, a range of postures, coordinated movements, hand-to-face movement control, suction, grip, support) in infants in the SG. With respect to motor control, comparative analysis of postconceptional ages according to age-bracket (I - 31-33 weeks 6/7; II - 34-36 weeks 6/7; and III - 37-39 weeks 6/7) revealed balanced tonus and coordinated voluntary movements in all three periods, a longer time spent in a range of postures (age bracket I) or in flexion (age bracket II) and more regular breathing in age bracket I in the SG. Conclusion: In the hospital, tactile and kinesthetic stimulation was shown to have a positive effect, contributing towards adjustment and self-regulation of behavior in the preterm newborn infant.
Article registered in the Australian New Zealand Clinical Trials Registry (ANZCTR) under the number ACTRN12610000133033.

Key words: preterm neonates; stimulation; child development; behavioral analysis.

Resumo

Objetivo: Avaliar o efeito da estimulação tátil-cinestésica na evolução do padrão comportamental e clínico de recém-nascidos pré-termos (RNPT) durante o período de internação hospitalar. Métodos: Trinta e dois RNPT, com peso ao nascimento inferior a 2.500 gramas, clinicamente estáveis e destituídos de asfixia perinatal importante foram divididos em 16 bebês do grupo controle (GC) e 16 do experimental (GE). Foram coletados dados da evolução clínica a partir dos registros hospitalares e da avaliação comportamental por meio de filmagens semanais de oito minutos, desde a inclusão do RNPT na amostra até a alta hospitalar. Resultados: Tendência a redução do tempo de internação hospitalar, aumento do ganho de peso diário e predominância de comportamentos auto-organizados (respiração regular, estado de alerta, tônus equilibrado, posturas mistas, movimentação coordenada, movimentos de mão na face, sucção, preensão, apoio) para os RNPT do GE. A análise comparativa das idades pós-conceptuais divididas em intervalos (I - 31 a 33 semanas 6/7; II - 34 a 36 semanas 6/7; e III - 37 a 39 semanas 6/7) ressaltou, no aspecto motor, um tônus equilibrado e movimentação voluntária coordenada para os três períodos, maior permanência em posturas mistas (intervalo I) ou em flexão (intervalo II) e a obtenção de respiração mais regular na faixa etária I do GE. Conclusão: Destaque da estimulação tátil-cinestésica como método de intervenção durante o período de internação hospitalar, contribuindo para a auto-organização e regulação comportamental de RNPT.
Artigo registrado no Australian New Zealand Clinical Trials Registry (ANZCTR) sob o número ACTRN12610000133033.

Palavras-chave: recém-nascido prematuro; estimulação; desenvolvimento infantil; análise do comportamento.

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Introduction

Premature birth, when combined with low birth weight, denotes atypical development characterized by greater disturbance and delays in several areas, with neurological, sensory and functional morbidities increasing as the birth weight decreases[1,2]. Differences in the times the sensory inputs are received seem to change the connectivity and the structure of the cerebral cortex, which justifies the poor neurofunctional performance of pre-term newborns (PTNBs) in tasks related to complex cerebral processes, such as attention and self-regulation[3].

Studies have been conducted on the implementation of PTNB care programs to decrease environmental components that generate stress and to promote a more favorable context to infant development during hospital stay[4-6]. The intervention programs take into account the daily care routine provided by the multidisciplinary health team or by the infant's parents. The main goal is to offer an extrauterine environment that is adequate for an immature physiological system. This goal requires a modified sensory environment capable of producing more stable behavioral responses, which are compatible with the critical period of cerebral development of the PTNB[7].

The responsiveness of newborns to tactile stimulation in the first days of life is greater than any other sensory modality. Furthermore, growth and cerebral maturity depend on neurotransmitters that are responsive to contact and gentle tactile stimulation. Tactile-kinesthetic stimulation stands out among the available interventions as an effective means to accelerate daily weight gain and to reduce the length of hospital stay of PTNBs[9,10].

In one of the studies, the authors verified the effect of tactile stimulation on the development of five PTNBs with low birth weight. The children who received tactile stimulation were more active, had quicker weight gain and were physically healthier in terms of growth and motor development[11]. Extremely PTNBs who received tactile-kinesthetic stimulation for 15 minutes, three times a day, for ten consecutive days, showed greater weight gain, longer periods of alertness and more mature patterns in the motor, habituation and orientation clusters of the Brazelton assessment scale. Furthermore, the PTNBs submitted to treatment had higher growth and development than the non-stimulated ones[12].

Despite the several benefits pointed out by studies in the area, there is still no consensus on the mechanisms responsible for the clinical and behavioral improvements or on which specific intervention scheme would be more suitable for each situation according to gestational age or birth weight[8,13]. The responses produced, moment by moment, by the child before, during and after the intervention may represent the most reliable and safest means to attune the stimuli to the baby's tolerance. This procedure could classify the stimuli as adequate or excessive[13] according to the resulting approach or avoidance behavior[14], respectively. The observation of the PTNB's body language in the context in which it occurs (i.e. during routine manipulations, painful procedures or during the infant's interaction with parents and staff) seems to be the most appropriate way of knowing when and how to intervene with decreasing risks to the infant's development. Thus, the present study aimed to investigate the behavioral and clinical development of PTNBs at low risk of neurological sequelae who took part in a tactile-kinesthetic stimulation program during their hospital stay in an intermediate care nursery.

Methods

In an initial screening, we selected 40 clinically stable PTNBs with birth weight below 2500 grams and 5-minute Apgar score equal to or greater than 6. However, eight babies were excluded due to the presence of one or more of the following criteria: visual and/or hearing dysfunction; neurological abnormality diagnosis evidenced by cranial ultrasound; clinical instability; short hospital stay and parental non-consent.

The selected infants came from an intermediate care nursery where the clinical data and the behavioral evaluation were collected and the tactile-kinesthetic stimulation was applied. The study was approved by the Research Ethics Committee of the University Hospital of Universidade de São Paulo (record no. 393/03), and the parents or guardians signed an informed consent form authorizing the participation of the PTNBs in the study.

Initially, data were collected from the control group (CG) and then from the experimental group (EG) to avoid mixing the groups and to avoid an unethical posture toward the parents and infants of the CG. The clinical data of the mothers and PTNBs were obtained from medical charts to prepare an anamnesis file containing the following information on the pregnancy and birth: prenatal care; gestational age (GA) starting from the date of the last menstruation, Capurro method or early ultrasound exam; weight; Apgar score and cause of prematurity. A follow-up file for each subject was used to record the daily weight gain, the length of hospital stay in days, the corresponding chronological age and occasional changes to the infants' general clinical status.

The behavioral assessment adopted for the present study was adapted from the Manual for the Naturalistic Observation of Newborn Behavior (Preterm and Full-Term Infants)[15]. This assessment includes the main subsystems or abilities of the PTNB, such as the autonomic nervous system (respiration, visceral signs and spasms), the motor system (muscle tonus and predominant posture), states of consciousness (quiet sleep, active sleep, drowsiness, quiet alert, active alert, crying) and social attention-interaction (approach and avoidance). These behaviors were recorded in percentage of time or frequency of occurrence, allowing the quantification of the behavioral observation and later statistical analysis.

The PTNBs of the CG and EG were filmed for 8 minutes without interruptions at each postconceptual week until hospital discharge. For the infants of the EG, the valid footage was the one taken one week after the beginning of the intervention protocol. A video camera (Panasonic NV – RJ28 Optical Zoom 23) was used to film the infant preferably one hour before the next feeding. The infants wore diapers only and were in the supine position in the incubator with a common or heated crib, depending on the place where it was situated in the nursery. Occasionally, a portable heater was needed to keep the PTNB warm, and the investigators had to avoid manipulation.

For the video analysis, the recorded footage was viewed, and the infant's behavior was written down by pausing the video at 30-second intervals to allow the full transcription of the behavioral data. These data were compared as a whole in the groups and within predefined intervals of postconceptual ages: 31 to 33 6/7 weeks (Interval I); 34 to 36 6/7 weeks (Interval II); 37 to 39 6/7 weeks (Interval III). This procedure was used to test for behavioral differences or to observe the evolution of these behaviors at shorter chronological intervals.

To minimize measurement errors of observed behaviors, inter- and intra-observer agreement of the results were verified by viewing the footage of 5 PTNBs in two different phases. In the first phase, the inter-examiner agreement index (AI) was calculated, and after one month, the intra-examiner AI was calculated (second phase). Both indexes reached satisfactory values, above 80%.

The tactile-kinesthetic stimulation protocol was applied to the EG and consisted of four or five weekly interventions of 5 to 15 minutes according to the individual stimulation thresholds of the infants and focusing on their state of alertness. The tactile stimulation consisted in smooth, slow and continuous stroking[9,16,17], with variable sequence, in the cephalocaudal direction and proximal to distal on the limbs, keeping the PTNB in the supine or lateral decubitus position. The kinesthetic stimulation involved slow limb mobilizations in flexion or extension, manual exploration by the infants of different parts of their bodies and adequate positioning in lateral or ventral decubitus, with the assistance of cloth rolls strategically placed in a nest shape[1,18-20].

The Mann-Whitney test was used for the comparison of the quantitative data obtained from independent samples (CG and EG). The test for equality of two proportions was used to compare the proportion of responses of the qualitative variables. For all analyses, the significance level was 0.05.

Results

The CG and EG consisted of 16 PTNBs each: five females and eleven males in the CG, and nine females and seven males in the EG. The mean birth weight and gestational age for the EG were 33.38 (±1.9) weeks and 1910.31 (±300.86) grams, and for the CG, 33.28 (±2.1) weeks (p=0.88) and 1872.81 (±407.85) grams (p=0.985). The sample's descriptive characteristics and the clinical variables were not statistically significant. However, for the EG, there was a tendency for reduction in the total length of hospital stay in days (13.44±8.57) compared to the CG (18.19±13.8; p=0.355), and an increase in daily weight gain (6.09±13.33 g) in the EG compared to the CG (4.53±26.66 g, p=0.851).

For the EG, the analysis of the combined behavioral assessment of the chronological ages showed a higher percentage of regular respiration time (p=0.002) in the autonomic subsystem and of time in the state of active alertness (p=0.036) in the state of consciousness subsystem. In the motor subsystem, the EG spent more time in mixed postures (p=0.013), with balanced tonus (p<0.001). For the CG, the extended posture (p=0.001) in hypotonia (p<0.001) was the main posture as shown in Figure 1. When comparing the means for voluntary movement, the EG performed more coordinated movements, with mean occurrence frequency of 4.76 (±3.94), compared to 1.12 (±1.86) for the CG (p<0.001), and a greater number of hand-to-face, suction, prehension and support movements (mean=10.8±5.48 for the EG and 7.19±5.66 for the CG; p=0.013).

In the social attention-interaction subsystem, the approach-avoidance behaviors did not exhibit significant differences between groups. In general, the mean approach for the EG (3.64±5.32) was greater than the mean for the CG (1.74±3.74). Avoidance was not observed in the EG, and the mean occurrence for the CG was 0.76 (±2.05).

Figure 2 shows the analysis of the behavioral assessment using the approach of postconceptual ages divided into intervals, which demonstrates that the motor subsystem was in balanced tonus for the three intervals of the EG (I - p=0.007; II - p=0.003; III - p=0.043) and in hypotonia for intervals I (p=0.014) and II (p=0.0017) of the CG. A higher percentage of time was spent on mixed postures (mean 75±32.39 for EG and 28.85±35.68 for CG, p=0.008) in interval I, and in flexion (mean 30.68±35.73 for EG and 8.63±8.63 for CG, p=0.012) in interval II for the EG. There was a significant occurrence of coordinated movement for all of the ages of the EG (I - p=0.001; II - p=0.027; III - p=0.044). In the autonomic subsystems, regular respiration occurred especially for the EG in interval II (p=0.008), while the other subsystems (state of consciousness and social attention-interaction) did not present significant differences.

Table 1. Sample's descriptive data and clinical results.

Characteristics	CG	SG	p-value
Gender			
Female	5	9	0.154
Male	11	7	0.154
Gestational age (weeks): mean (SD)	33.28 (2.1)	33.38 (1.9)	0.88
Birth weight (g): mean (SD)	1872.81 (407.85)	1910.31 (300.86)	0.985
Apgar score (mean):			
1st minute	9	8	0.268
5th minute	9	9	0.383
10th minute	10	9	0.032*
BW classification:			
LBW	12	15	0.144
VLBW	4	1	0.144
BW classification according to GA:			
AGA	11	14	0.2
SGA	5	2	0.2
Length of hospital stay (days): mean (SD)	18.19 (13.8)	13.44 (8.57)	0.355
Daily weight gain (g): mean (SD)	4.53 (26.66)	6.08 (13.33)	0.851

g: grams; SD: standard deviation; BW: birth weight; LBW: low birth weight; VLBW: very low birth weight; GA: gestational age; AGA: appropriate for GA; SGA: small for GA.

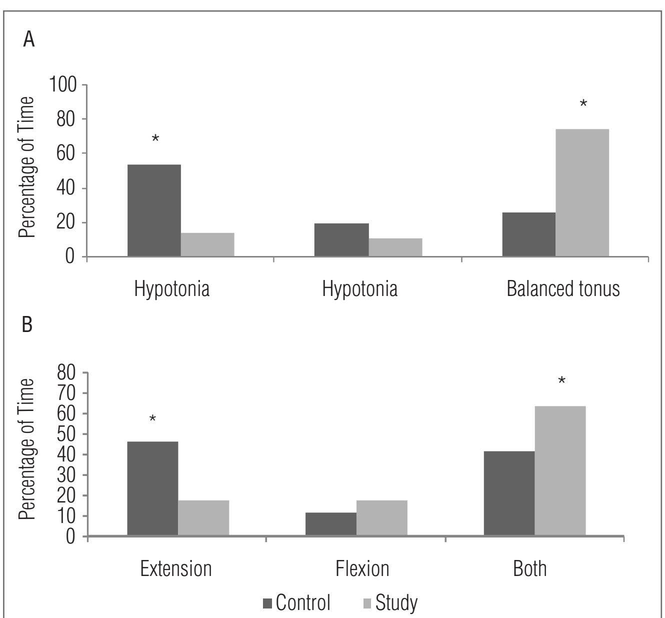

Figure 1. Comparison of the mean percentages of time for the items muscle tonus (A) and predominant posture (B) between the control and experimental groups.

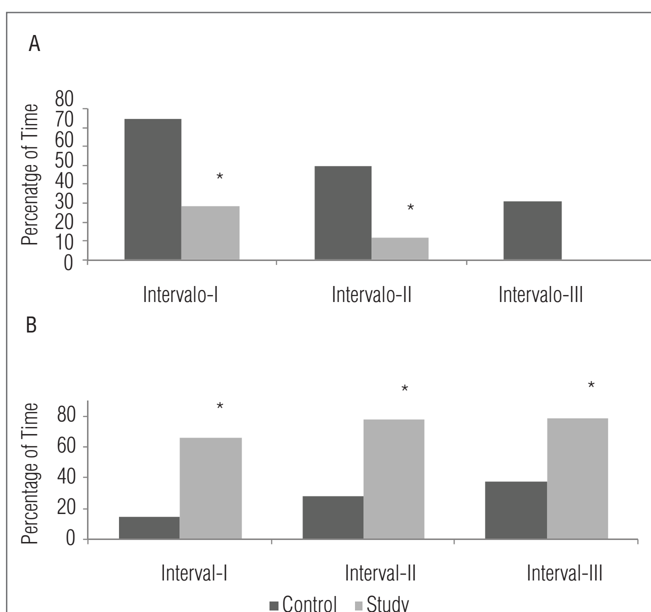

Figure 2. Comparison of the mean percentages of time for the items hypotonia (A) and balanced tonus (B) between the control and experimental groups.

Discussion

The present study assessed the clinical and behavioral aspects of PTNBs who received tactile-kinesthetic stimulation during hospital stay. The majority of studies demonstrated improvement in the clinical measures related to weight gain and a reduction in the length of hospital stay[8,9,11,21-24]. The results of the present study point to a tendency for reduction in the length of hospital stay and for an increase in daily weight gain for the PTNBs of the stimulated group, but without statistical significance. A current review on this topic included 14 randomized studies, in which PTNBs or low birth weight infants were massaged for approximately 15 minutes, three to four times a day, for five to ten days, resulting in a weight increase of 5 grams and a reduction of 4.5 days in the length of hospital stay[8]. However, methodological differences between studies made the comparisons of the results inconsistent and the effectiveness of the intervention questionable, e.g. the varying number of infants, amounts of stimulation, total duration of each stimulation, and different types of stimuli (from gentle to intense stroking) applied by the parents or medical team.

Table 2. Behavioral results for the control group (CG) and experimental group (EG).

Behavioral Analysis		mean (SD)	median	p-value
Chronological age (weeks)	CG	34 4/7 (1.99)	35	0.844
	EG	34 5/7 (2.09)	34	
Regular breathing (%)	CG	61.61 (42.36)	87.5	0.002*
	EG	91.5 (21.72)	100	
Irregular breathing (%)	CG	38.39 (42.36)	12.5	0.002*
	EG	8.5 (21.72)	0	
Hypotonia (%)	CG	54.17 (42.94)	71.88	< 0.001*
	EG	14.25 (30.96)	0	
Hypertonia (%)	CG	19.64 (22.66)	9.38	0.108
	EG	11.25 (15.83)	6.25	
Balanced tonus (%)	CG	26.19 (39.32)	0	< 0.001*
	EG	74.5 (31.51)	93.75	
Extended posture (%)	CG	46.58 (40.46)	46.88	0.001*
	EG	17.75 (20.23)	6.25	
Flexed posture (%)	CG	11.76 (28.46)	0	0.384
	EG	18 (27.74)	0	
Both postures (%)	CG	41.67 (37.36)	31.25	0.013*
	EG	64.25 (30.06)	75	
Coordinated movements (f)	CG	1.12 (1.86)	0	< 0.001*
	EG	4.76 (3.94)	4	
Uncoordinated movements (f)	CG	4.36 (4.51)	2.5	0.09
	EG	2.64 (2.75)	2	
Hand-to-face/Support movements (f)	CG	7.19 (5.66)	6.5	0.013*
	EG	10.80 (5.48)	13	
Quiet sleep (%)	CG	14.29 (29.42)	0	0.15
	EG	4.75 (18.34)	0	
Active sleep (%)	CG	59.38 (42.24)	75	0.33
	EG	48.75 (43.9)	62.5	
Drowsiness (%)	CG	5.95 (12.95)	0	0.627
	EG	7.5 (11.83)	0	
Quiet alertness (%)	CG	8.78 (19.91)	0	0.209
	EG	16 (26.4)	0	
Active alertness (%)	CG	8.93 (18.58)	0	0.036*
	EG	21.75 (30.47)	0	
Crying (%)	CG	2.68 (8.53)	0	0.435
	EG	1.25 (4.03)	0	
Attention-Interaction approach (f)	CG	1.74 (3.74)	0	0.091
	EG	3.64 (5.32)	0	
Attention-Interaction avoidance (f)	CG	0.76 (2.05)	0	0.068
	EG	0 (0)	0	

%: time percentage; f: frequency of occurrence; SD: standard deviation.

In addition to the reduced sample size of the present study, there were also variations in stimulation time, according to individual thresholds, and in the total number of sessions held for each infant because the intervention was held from the time the infant reached clinical stability until hospital discharge. These factors may have hampered the adequate standardization of the stimulation, contributing to the lack of significance of the clinical results.

In the behavioral aspect, many studies observed the premature behavior to assess the interventions, which can vary from simple positioning to more complete programs of developmental care[4,18,19]. The responses produced by the infants suggest self-regulation by a more contained flexed posture, with organized hand-to-face/mouth movements, suction, object prehension or limb support. In contrast, stressful behaviors may be represented by disorganized movements, extension and hypotonia[19,25]. Investigators collected saliva samples and quantified cortisol levels to analyze the stress level of healthy newborns submitted to tactile stimulation or to a combination of two of the following stimuli: tactile, visual, auditory and vestibular. The group submitted to tactile stimulation only had a significant increase in cortisol levels, whereas the multisensory stimulation group had a decline in the level of this hormone. This suggested a preference by the newborns for combination of stimuli, such as tactile-kinesthetic stimulation[26].

Tactile-kinesthetic stimulation is accompanied by improvements in motor activity, which can be demonstrated by increased movement variability, suction, periods of alertness and reduced hypotonia[10,12,21,27,28]. In the combined analysis of the chronological ages, the EG spent more time in a state of alertness, had regular respiration, mixed postures, balanced tonus and coordinated voluntary movements, with hand-to-face movements, suction, prehension and limb support, while the CG demonstrated irregular respiration, extension and hypotonia for a longer period of time. In the analysis of the groups' interval subdivision, the stimulated group showed balanced tonus, coordinated movement in the three intervals, prevalence of mixed postures in interval I and flexed postures in interval II, whereas the CG exhibited significant hypotonia in intervals I and II. These results for the group total and the chronological age intervals agree with other studies that also found more mature patterns among the stimulated infants and hypotonia and extended posture among the control PTNBs[11,12].

Due to the immaturity of the neuromotor system, the PTNB's muscular tonus can be naturally lower after birth, following distinct periods of myelination of the descending motor tracts and cephalocaudal development. Furthermore, the PTNB may suffer external influences of the predominantly extended posture[20]. At 34 weeks gestational age, the PTNB may show lower limb flexion around the hips and knees, and the arms extended and relatively hypotonic (frog posture). Starting at 36 weeks, the PTNB increases the flexor tonus in the extremities[29]. Therefore, in interval II (from 34 to 36 weeks), the presence of hypotonia with mixed posture in limb flexion or extension, as experienced by the CG, was expected. Actually, it was observed that the EG demonstrated mixed postural patterns starting at interval I (31 to 33 6/7 weeks) and in flexion, with a balance-prone tonus in interval II.

Before 32 postconceptual weeks, the PTNB's movements are broad and fast. From then on, limb movements gradually become more flexed, slower and less broad[30]. Such coordinated patterns were found in the EG in all the evaluated phases, whereas uncoordinated voluntary movements in the CG were more frequent, although non-significant.

In the autonomic subsystem, regular respiration was observed in interval II of the EG, while the other subsystems did not show significant differences. In general, the non-stimulated group spent more time in the quiet alert state and the stimulated group in the active and quiet alert states, as previously described by other studies[8,12].

The quality of the behavioral responses produced by the PTNBs when undergoing stimulus is strongly dependent on the state in which they find themselves and on internal and external events, such as time elapsed since the last feeding, drowsiness, pain, noise, lighting and temperature[13]. Attention was also given to environmental conditions and to the medical team's manipulations prior to the behavioral assessment, however not all of these aspects could be properly controlled. Thus, the PTNBs remained vulnerable to the stimulus inherent to the nursery, which may have competed with the tactile-kinesthetic stimulation or masked important behavioral aspects, such as states of consciousness and social attention-interaction.

Although the experimental conditions of the present study were not totally adequate, some behavioral patterns were observed in both analyses (groups or intervals), such as balanced tonus, mixed or flexed postures and coordinated movements for the stimulated PTNBs. The other subsystems were not affected as much as the motor system, however the group analysis showed regular respiration and the predominance of the active alert state in the stimulated PTNBs.

According to other studies, it is possible to conclude that the tactile-kinesthetic stimulation was an effective intervention method for the behavioral development of the PTNBs because they demonstrated more mature motor patterns and more regulated and organized behaviors. However, other multidisciplinary studies on this type of intervention are needed to assess the clinical and behavioral progress and long-term neurological and psychomotor development of these PTNBs and to contribute effectively to the improvement of the current and future quality of live of these infants.

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