

Effect of specific, short-term training on the acquisition and retention of manual reach in premature, low birth weight infants**Efeito do treino específico e de curta duração na aquisição e retenção do alcance manual em lactentes prematuros e baixo peso ao nascimento****Efecto del entrenamiento específico y de corta duración en la adquisición y retención del alcance de la mano en bebés prematuros y de bajo peso al nacer****Received: 01/04/2019****Approved: 12/03/2020****Published: 29/07/2020****Gabriella Contarin Barbosa¹****Elaine Leonezi Guimarães²**

This is a descriptive, longitudinal study, with a convenience sample of an applied nature, developed from February to December of 2018, and aiming of verify whether a specific training, a series of varied and short-term practice conditions, influence the behavior of manual reach and skill retention in preterm infants with low birth weight. Six infants of both genders participated, randomly divided into: experimental group, which received specific training; and control group, which received only social interaction. 180 ranges of both groups were analyzed. Although without statistically significant difference, but with clinical relevance, the results showed that specific training promoted an improvement in the total frequency of the reach ($d = 0.88$, 95% CI), and, in distal adjustments of reach (oblique and semi-open hand), in the experimental group in relation to the control group. In the kinematic parameters of range, the results showed a more organized range, indicating that something was learned and/or changed in the period immediately after training, however, learning retention was not verified. Thus, it is believed that more prolonged training is necessary to obtain learning retention.

Descriptors: Infant; Infant, premature; Early intervention.

Este é um estudo de caráter descritivo, longitudinal, com amostra por conveniência de natureza aplicada, desenvolvido de fevereiro a dezembro de 2018, e com o objetivo de verificar se o treino específico, condição de prática variada seriada e de curta duração, influenciam o comportamento de alcance manual e a retenção da habilidade em lactentes pré-termo com baixo peso ao nascimento. Participaram seis lactentes de ambos os sexos, aleatoriamente divididos em: grupo experimental, que recebeu treino específico; e grupo controle, que recebeu apenas interação social. Foram analisados 180 alcances de ambos os grupos. Embora sem diferença estatisticamente significativa, mas com relevância clínica, os resultados demonstraram que o treino específico promoveu melhora na frequência total do alcance ($d=0,88$, 95% IC), e, nos ajustes distais do alcance (mão oblíqua e semiaberta), no grupo experimental em relação ao grupo controle. Nos parâmetros cinemáticos do alcance, os resultados mostraram um alcance mais organizado, indicando que algo foi aprendido e/ou mudado no período imediato ao treino, contudo, não foi verificada a retenção da aprendizagem. Assim, acredita-se ser necessário um treino mais prolongado para se obter a retenção da aprendizagem.

Descritores: Lactente; Recém-nascido prematuro; Intervenção precoce.

Este es un estudio descriptivo longitudinal, con una muestra por conveniencia de naturaleza aplicada, desarrollado de febrero a diciembre de 2018, y con el objetivo de verificar si el entrenamiento específico, una condición de práctica variada en serie y de corta duración, influye en el comportamiento de alcance de la mano y la retención de la habilidad en los lactantes prematuros con bajo peso al nacer. Participaron seis bebés de ambos sexos, divididos aleatoriamente en: grupo experimental, que recibió entrenamiento específico; y grupo de control, que sólo recibió interacción social. Se analizaron 180 alcances de ambos grupos. Aunque sin diferencias estadísticamente significativas, pero con relevancia clínica, los resultados mostraron que el entrenamiento específico promovió una mejora en la frecuencia total del alcance ($d=0,88$, 95% IC), y, en los ajustes distales del alcance (mano oblicua y semiabierta), en el grupo experimental en relación con el grupo de control. En los parámetros cinemático del alcance, los resultados mostraron un alcance más organizado, lo que indica que algo se aprendió y/o cambió en el período inmediato del entrenamiento, sin embargo, no se verificó la retención del aprendizaje. Por lo tanto, se cree que se necesita un entrenamiento más largo para lograr la retención del aprendizaje.

Descritores: Lactante; Recien nacido prematuro; Intervención precoz.

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INTRODUCTION

Throughout the infant's development, motor skills, such as manual reach, are acquired and improved. Manual reach is defined as the ability to locate and touch objects in space, through a trajectory performed by one or both hands^{1,2}. The beginning of this skill occurs in the first months of life (3-4 months in healthy infants), according to the interaction of factors, such as changes in development, acquisition of coordination, perception of the physical properties of the object, antigravity force and better targeting of upper limbs³. However, although reaching seems to be a simple task, it requires major adjustments by the infant^{1,3}.

Studies show that the quality of reach in low-risk preterm infants is less satisfactory than in full-term infants⁶. However, scientific evidence that demonstrates whether a few minutes of training is sufficient to promote measurable changes in reaching behavior in preterm and low birth weight infants is still scarce in the period of emergence of this skill¹.

Considering such scarcity, the training effect has received considerable attention in motor learning studies using a variety of tasks, different contexts and method of analysis of movement, especially of manual reach in infants³⁻¹².

Thus, we raised the following question: *A specific training, in a condition of varied serial practice, of short duration, in the emergence of the skill, is able to interfere in quality, frequency and learning of manual reach behavior in preterm infants with low birth weight?*

Seeking to answer this question, the present study aimed to verify whether specific training, a condition of varied serial practice, of short duration, influences the behavior of manual reach and skill retention in preterm infants with low birth weight.

METHOD

This descriptive, longitudinal study, with a convenience sample of an applied nature, was developed from February to December of 2018, at the Electromyography and Kinematics Laboratory (*Laboratório de Eletromiografia e Cinemática - LAELCIN*), Department of Applied Physiotherapy, Universidade Federal do Triângulo Mineiro (UFTM), after approval by the UFTM Human Research Ethics Committee, opinion No. 1856/2011 and registered in the Brazilian Registry of Clinical Trials (*Registro Brasileiro de Ensaio Clínicos - ReBEC*) No. RBR-4RJWRX.

Six infants born preterm (gestational age between 30 and 33 weeks), with low weight (between 1125 and 2210 grams) at birth, and exposed to risk conditions at birth requiring hospitalization, incubator and phototherapy participated in this study. Three preterm infants who received the specific training of intrasession range comprised the experimental group (EG) and were compared to three preterm infants, who composed the control group (CG), who did not receive specific intrasession training, there was only interaction with the examiner.

No infant had a clinical diagnosis of brain injury, and all had an Apgar score greater than or equal to seven in the first and fifth minutes, adequate motor performance (percentile greater than or equal to 25) according to the Alberta Infant Motor Scale (AIMS)¹³, and did not attend daycare centers. Parents and/or guardians authorized their child's participation through the Free and Informed Consent Form. To homogenize the sample, the Brazilian Economic Classification Criterion of the Brazilian Association of Research Companies (*Associação Brasileira de Empresas de Pesquisa - ABEP*) was considered.

Non-inclusion criteria in the study were considered: extremely risky infants, for having a gestational age of less than 29 weeks, Apgar score below seven in the first and fifth minutes, congenital changes in the central nervous system, signs of neurological impairment, musculoskeletal changes, genetic syndromes or withdrawal symptoms associated with reports of maternal alcohol and drug abuse, congenital infections, sensory deficits, cardiorespiratory difficulties.

For evaluations, a children's dining chair with a 45° reclining back was used, completely covered in black, adapted for the study, a malleable latex object, attractive, of red color for

stimulation of reach. To facilitate tracking of movement, a black bracelet with a 0.5 cm diameter jewelry pearl was placed on the dorsal region of the infant's wrists^{3,4,8}. For the capture and kinematic analysis of the reach movement, the Dvideow 5.0® Videogrammetry system was used using a specific arrangement¹⁴.

During evaluations, the infants presented themselves in an inactive state of alert (with open eyes, not crying and not showing gross movements), or in an active state of alert (with open eyes, not crying, but exhibiting gross movements). With the markers on the wrists, the infants were positioned in the infant chair in the reclined position at 45°, with the examiner's support at the time of the xiphoid process to provide better trunk stability. An interval of 10 seconds, infant was allowed to adapt to the situation, and then the evaluation started. The total period of each evaluation lasted approximately 2 minutes.

All infants were submitted to three evaluations, two performed in sequence, in a single day: 1) pre training, before the training session; 2) post training, immediately after the training session, and, 3) after 22hs (\pm 2hs) of the first assessment for both groups, in order to measure the learning permanence of the reach (retention measure) in the trained group, and to verify possible difference in skill in relation to the untrained group.

The training was always performed in the 45° reclined posture, according to the protocol described^{3,8}, seeking interaction of the infant with the object. It lasted approximately 5 minutes, and the series of activities was repeated 10 times for each upper limb, without repeating the same activity consecutively, starting with the right upper limb. Range was considered when the infant located the object in space, fixed their gaze on it, and performed the movement with one or both upper limbs towards the target, until touching it, with or without gripping.

The analysis of the reach behavior for the present study was performed using categorical variables (proximal adjustments: unimanual and bimanual reach, and distal adjustments: palm orientation, surface and hand opening) and continuous variables (frequency and motion kinematics). For statistical analysis of the data, Wilcoxon's nonparametric test was used for intragroup analysis and for Mann-Whitney intergroup analysis using the SPSS (Statistical Package for Social Sciences) version 20.0. In order to verify the magnitude of the intergroup effect, the Cohens'd test was used for independent measurements, for the kinematic parameters of the range. And yet, the simple descriptive analysis, through absolute frequency, medians and quartile interval, considering the pre-training, post-training and retention measures. For all analyzes, a significance level of 5% was considered.

RESULTS

According to birth data, the age of acquisition of reach, as well as exposure to risk conditions, described in tables 1 and 2, both groups were at risk for delayed motor development.

Table 1. Birth data and acquisition of the infant's manual reach. Uberaba, MG, 2018.

Group	Number of Participants	Gender		GA	BW	Apgar		AAR	TAR
		F*	M*			1°	5°		
Experimental	3	2	1	32.0 (\pm 1.7)	1408 (\pm 553.1)	9.0 (\pm 0.5)	9.0 (\pm 0.5)	14.5 (\pm 3.06)	2.3 (\pm 0.58)
Control	3	0	3	33.0 (\pm 0.0)	2000 (\pm 251.3)	9.0 (\pm 1.5)	9.0 (\pm 0.0)	11.8 (\pm 2.75)	1.3 (\pm 0.58)

Key: Gender: M *, male; F *, female; GA, Gestational age (weeks); BW, birth weight (grams); Apgar in the first minute; Apgar in the fifth minute; AAR, Age of acquisition of reach (weeks); TAR, time of acquisition of reach (days); (\pm), standard deviation of the mean.

Table 2. Characterization regarding exposure to risk conditions for the infant's development. Uberaba, MG, 2018.

Group	CA	CoA	ERT	Alberta	ABEP	LS	TInc	PT
Experimental	19.0 (±5.1)	3.5 (±0.7)	2.0 (±0.5)	50.0 (±14.0)	2.0 (±0.5)	32.0 (±16.0)	26.0 (±14.0)	5.0 (±2.0)
Control	17.0 (±3.2)	3.0 (±0.5)	1.3 (±0.5)	25.0 (±28.0)	4.0 (±0.5)	21.0 (±7.0)	9.0 (±5.8)	4.0 (±1.72)

Key: CA, chronological age (weeks); CoA, Corrected age (weeks); ERT, Emergency reach time (days); ABEP, socioeconomic classification (B2: 23-28; C1: 18-22); Alberta (AIMS), total score percentile ≥ 25 ; LS - length of stay (days); TInc - Time in the incubator (days); PT - Phototherapy time (days); (\pm), standard deviation of the mean.

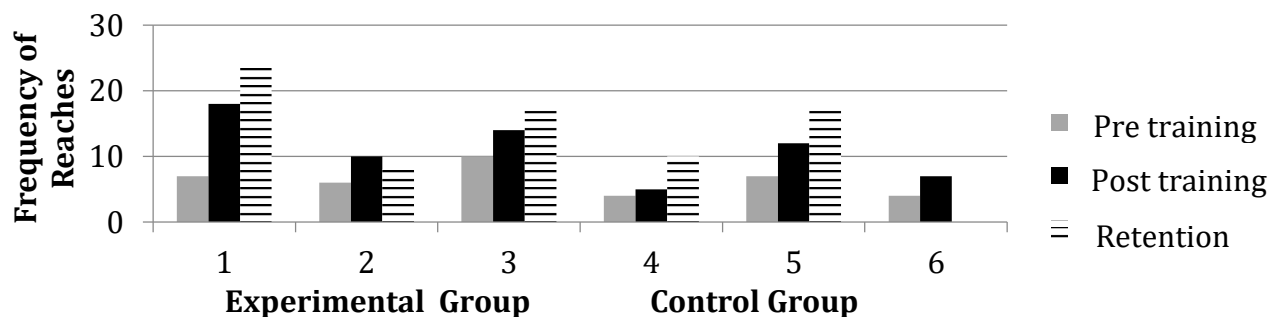
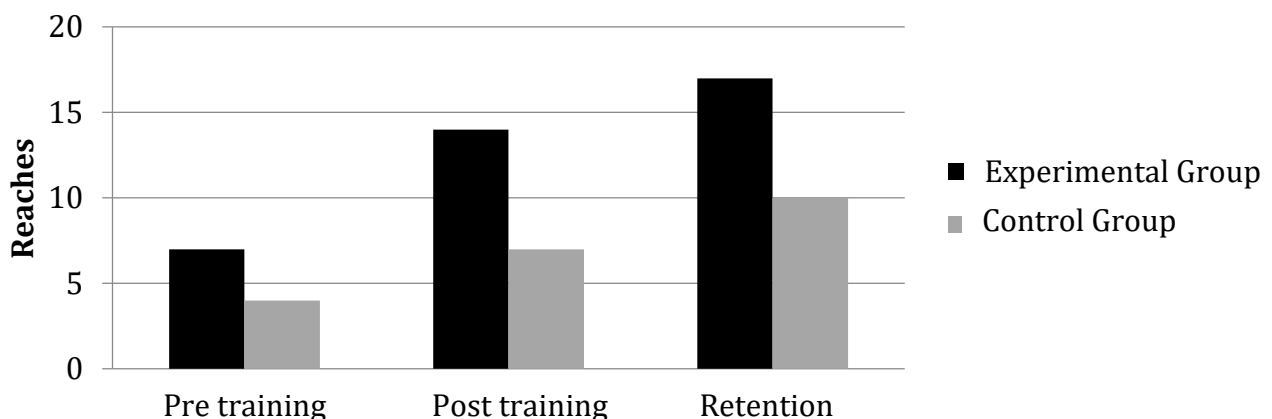
In both groups, 180 ranges were analyzed, automatically tracked by the analysis system used (Dvideow 5.0®) (Table 3).

Table 3. Scopes analyzed in each group. Uberaba, MG, 2018.

Group	Number of participants	Number of reaches analyzed			Total number of reaches
		Pre training	Post training	Retention	
Experimental	3	23	42	49	114
Control	3	15	24	27	66
Total	6	38	66	76	180

Total Frequency of Reaches

There was no statistically significant difference in the total frequency of reach between pre-training, post-training and retention for both groups (Graph 1). However, when analyzing the magnitude of the effect (Cohen's d) on the frequency of reaching, there was a great effect with clinical relevance ($d = 0.88$, 95% CI) of the training in the EG (Graph 2).

Graph 1. Frequency of reaching pre-training, post-training and retention, in the experimental group (1, 2 and 3) and in the control group (4, 5 and 6). Uberaba, MG, 2018.**Graph 2.** Clinical relevance of the training ($d = 0.88$, 95% CI), observed by the difference in the mean range observed in the experimental group in relation to the control group. Uberaba, MG, 2018.

Proximal Adjustments

As for the proximal adjustments, although with no statistically significant difference, a higher frequency of unimanual ranges was observed in both groups, with a median of 6.0 ± 1.0 ranges in the pre training, 10.0 ± 6.0 in the pre training, post training, and 9.0 ± 1.5 in retention in the EG, and in the CG, 4.0 ± 1.7 in the pre, 7.0 ± 3.0 in the post and 6.0 ± 7.0 in the retention.

Distal Adjustments

As for the palm orientation, there was a higher frequency of oblique hand in both groups, with 3.0 ± 0.0 being observed in pre training; 9.0 ± 3.0 in the post-training, and 7.0 ± 4.0 ranges in retention in the EG. While in the CG, the median of 3.0 ± 2.0 ranges was observed in the pre-training; 2.0 ± 4.0 in the post, and 4.0 ± 2.0 in the retention, and still reaching with the horizontal hand only in the CG (3.0 ± 1.5 in the pre-workout; 4.0 ± 1 , 0 in the post, and 4.0 ± 6.0 in the retention).

Regarding the hand contact surface, there was a higher frequency of ventral surface in the EG (pre 5.0 ± 1.0 ; post 6.0 ± 4.0 and retention 7.0 ± 8.0), and in the larger CG frequency of the dorsal surface (pre 3.0 ± 2.5 ; post 6.0 ± 3.0 and retention 6.0 ± 8.0).

For the opening of the hand, there was a higher frequency of semi-open hand in the EG (pre 6.0 ± 0.5 ; post 12.0 ± 3.0 and retention 9.0 ± 6.0), than in the CG (pre 2, 0 ± 0.5 ; post 4.0 ± 1.0 and retention 3.0 ± 4.0).

Kinematic Analysis

As for the kinematic analysis of the intra-group range, there was no statistically significant difference between post training and retention in both groups. However, when analyzing the magnitude of the effect between post-training and retention, there was a great positive effect ($d = 0.91$, 95% CI), with educational difference ($d > 0.50$) in the average speed, and moderate negative effect ($d = -0.51$, 95% CI), with educational difference ($d > 0.50$) in the duration of the movement and peak speed ($d = -0.59$, 95% CI).

In the intergroup analysis, there was a statistically significant difference only for the peak speed ($U = -1.96$ $p = 0.05$) and the average speed ($U = -1.96$ $p = 0.05$), both increased in the EG in the retention. However, through the effect magnitude test (Cohen's d), analyzing only the retention between the groups, there was a small positive effect with educational significance, in the duration of the movement ($d = 0.33$, 95% CI), moderate positive effect with clinical relevance, in the adjustment index ($d = 0.71$, 95% CI), and, great positive effect with practical relevance, in the peak of speed ($d = 1.32$, 95% CI), in the index of straightness ($d = 0.89$, 95% CI) and, in the movement unit ($d = 1.83$, 95% CI).

DISCUSSION

This study investigated whether a specific training, condition of varied serial practice, of short duration, is able to influence the behavior of manual reach and retention of the ability in preterm infants with low birth weight.

According to the results presented, there was an increase in the frequency of manual reach in the EG immediately after a single short training session, as well as in retention. The immediate post training results corroborate the findings of other studies^{3,5,7,15-17}, confirming the hypothesis that training can improve the ability to reach objects, however, it is not yet possible to infer whether there is retention of this ability at short term.

The results demonstrated that the specific training promoted an improvement in the performance of the intra and intergroup task, observing an increase in the total frequency of reach in the EG in relation to the CG, and in the distal adjustments (oblique and semi-open hand) of the reach, a standard considered adequate for the period emergency of skill¹⁷. Similar results, although with different types and duration of training, were observed in infants born at less

than 33 weeks of gestation and underweight⁵, in late preterm infants (born between 34 and 36 6/7 weeks of gestation)⁸, and , in preterms less than or equal to 33 weeks of gestation and low birth weight^{3,16}.

One study compared the range of full-term infants submitted to social training, with preterm infants submitted to daily training, without defining the condition of practice, and of long duration (20 minutes daily, every day of the week, during 8 weeks, and performed by the caregiver guided by the physiotherapist)⁵, demonstrating that, after 8 weeks of training, there was an increase in hand contact with the object, more consistent reach and with a longer time of interaction with the toy. Similar data were observed in the present study, however, with a single short training session (approximately 5 minutes) performed by the physiotherapist.

When training in two practice conditions was compared: block and varied series, in late preterm infants⁷, it was found that only training in serial varied practice condition had an effect, however, there was no effect on the retention assessment, corroborating the findings of the present study. This conclusion can be attributed to the reduced number of participants in both studies, as well as the need for training with a longer duration.

In a study with preterm infants (less than or equal to 33 weeks of gestation) and low birth weight, using training in the condition of serial varied practice, evaluating pre and immediate post-training, there was a positive effect on proximal adjustments and distal reach³, confirming the findings in the distal adjustments of the present study.

The results of the present study are similar to the research in which it was found that a single training session, a condition of varied serial practice, of short duration, promoted an increase in the frequency of reaching, although it was in term infants⁸.

In relation to the opening of the hand, it was observed in investigations, a higher frequency of reaching with the semi-open hand in the post training and retention in both groups, indicating possible adaptations to intrinsic and extrinsic factors, which may favor distal adjustments of reach through the perception of physical properties of the object¹⁵⁻¹⁷. The results also corroborate results obtained in research⁸, demonstrating that, in the period of acquisition of reach, the semi-open hand seems to be the strategy used by full-term infants, in order to adjust the hand to the object, and that the specific practice of a few minutes can influence the recognition of the object also in the preterm infant.

Regarding hand orientation, there was a predominance of reach with oblique orientation. Studies show that the greater frequency of reaching with oblique orientation of the hand indicates that infants are in the stage of refining the reach, so that up to 5 months of age obtain adequate supination of the forearm^{15,16}.

Regarding the type of training, there are few studies reporting the training protocol in infants. An investigation with late preterms⁷ demonstrated that the block practice, considered of high contextual interference for acquisition in children, did not show improvement in reaching behavior in infants, but the serial varied practice had an influence, increasing frequency of reaching these infants, in the period immediately after training. However, no retention, defined as learning the skill, was verified one day after training. This limits generalizations of the effect of contextual training interference in infants, especially preterm and low birth weight.

As no clear effects of training on retention in late preterm infants are observed in investigations⁷ and, in preterm infants with low birth weight¹, more studies are needed, with a greater number of participants, a longer training time, in different populations considered at risk, seeking to verify the retention of learning.

The results of the kinematic parameters of reach between groups showed a significant difference in peak speed and average speed, both increased in measure of retention (24 hours after training), while, even without statistically significant difference, there was an increase in the duration of movement, in the straightness index, in the adjustment index and in the decrease of the movement unit in the EG, suggesting a more organized reach, and, indicating that

something was learned and/or changed in the immediate period to the training session, however, it was not verified learning retention. However, the significant increase in peak speed and average speed of manual reach, observed in the experimental group, in the retention measure, may indicate the need for a longer training for a more organized reach.

The observed changes, according to the effect magnitude test (Cohens'd), in the kinematic parameters of the range, with moderate effect and clinical relevance, in the average speed and in peak speed, suggest faster movements in the experimental group in comparison with the control group, in the measure of retention.

The moderate effect with clinical relevance in the adjustment index suggests an increase in movement deceleration in the experimental group compared to the control after training, facilitating the more precise range. And yet, the slight decrease in the movement unit, that is, less corrections in the reach movement, observed after the training, indicates another positive effect of the training.

Thus, the training favored a manual reach with more adjustments and fewer movement units, corroborating the other results found³, as well as, some learning to perform the movement by trained infants. However, it is believed that longer training is necessary to obtain learning retention.

CONCLUSION

Considering the increase in frequency and change in reach behavior in trained infants, with proximal and distal adjustments closer to the reach considered mature, as well as the effect and clinical relevance of training on some of the kinematic parameters of the skill, it is possible to answer, albeit with limitations, the initial question of the present study, that specific and short training is capable of influencing manual reach behavior. However, the same cannot be said for skill retention. Thus, further studies are needed in order to determine the best type of training and training time, so that the findings can be generalized to different populations of infants.

It should be noted that the use of manual reach training as an intervention strategy to promote sensorimotor experiences, can provide new movement strategies, facilitating greater exploration of the environment, and contribute to the development of the infant. Also, manual training is easy to apply and can be used in early intervention sessions, performed by physiotherapists and occupational therapists, as well as, directed to parents/caregivers to be performed in the home environment.

Limitations of the present study should be considered, such as the small number of participants, the heterogeneity of the sample, as very premature infants and with low birth weight are characteristically different, the lower the gestational age and birth weight, the greater the risk of injuries specific brain disorders, which can cause functional difficulties.

Such changes can be transient or persist for a long term, requiring a longer follow-up. Thus, a specific training of short duration may not be sufficient and suitable for all conditions of prematurity and low weight, requiring different types of training and for a longer time.

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CONTRIBUTIONS

Elaine Leonezi Guimarães contributed to the conception, data collection and analysis, writing and revision. **Gabriella Contarin Barbosa** participated in conception, data collection and analysis and writing.

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