Original Article

Artigo Original

Impact of auditory training for perceptual assessment of voice executed by undergraduate students in Speech-Language Pathology

Impacto de treinamento auditivo na avaliação perceptivo-auditiva da voz realizada por estudantes de Fonoaudiologia

Regiane Serafim Abreu Silva[1]
Marcia Simões-Zenari[2]
Nair Kátia Nemr[2]

Keywords

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Voice quality
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ABSTRACT

Purpose: To analyze the impact of auditory training for auditory-perceptual assessment carried out by Speech-Language Pathology undergraduate students. **Methods:** During two semesters, 17 undergraduate students enrolled in theoretical subjects regarding phonation (Phonation/Phonation Disorders) analyzed samples of altered and unaltered voices (selected for this purpose), using the GRBAS scale. All subjects received auditory training during nine 15-minute meetings. In each meeting, a different parameter was presented using the different voices sample, with predominance of the trained aspect in each session. Sample assessment using the scale was carried out before and after training, and in other four opportunities throughout the meetings. Students' assessments were compared to an assessment carried out by three voice-experts speech-language pathologists who were the judges. To verify training effectiveness, the Friedman's test and the Kappa index were used. **Results:** The rate of correct answers in the pre-training was considered between regular and good. It was observed maintenance of the number of correct answers throughout assessments, for most of the scale parameters. In the post-training moment, the students showed improvements in the analysis of asthenia, a parameter that was emphasized during training after the students reported difficulties analyzing it. There was a decrease in the number of correct answers for the roughness parameter after it was approached segmented into hoarseness and harshness, and observed in association with different diagnoses and acoustic parameters. **Conclusion:** Auditory training enhances students' initial abilities to perform the evaluation, aside from guiding adjustments in the dynamics of the university subject.

Descritores

Voz
Qualidade da voz
Distúrbios da voz
Treinamento da voz
Ensino superior
Fonoaudiologia
Percepção auditiva

RESUMO

Objetivo: Analisar o impacto de treino auditivo na avaliação perceptivo-auditiva da voz realizada por estudantes de Fonoaudiologia. **Métodos:** Durante dois semestres, 17 estudantes que cursavam disciplinas teóricas de fonação (Fonação/Distúrbios da Fonação) analisaram amostras de vozes alteradas e não alteradas (selecionadas para este estudo), por meio da escala GRBAS. Todos receberam treinamento auditivo durante um total de nove encontros semanais, com cerca de 15 minutos de duração cada. Em cada encontro foi apresentado um parâmetro, por meio de vozes diferentes da amostra avaliada, com predominância no aspecto treinado. A avaliação das amostras por meio da escala foi realizada pré e pós o treinamento e em outros quatro momentos ao longo dos encontros. As avaliações dos alunos foram comparadas com uma avaliação de juízas, realizada previamente por três fonoaudiólogos, especialistas em voz. Para verificar a efetividade do treinamento foi usado o teste de Friedman e Índice de Concordância Kappa. **Resultados:** O índice de acertos dos alunos no momento pré-treinamento foi considerado entre regular e bom. Observou-se manutenção do número de acertos ao longo das avaliações realizadas, para a maioria dos parâmetros da escala. No momento pós-treinamento observou-se melhora na análise da astenia, parâmetro enfatizado a partir das dificuldades apresentadas pelos alunos. Houve diminuição dos acertos no parâmetro rugosidade após este ter sido trabalhado de maneira segmentada em rouquidão e aspereza, e associado a diferentes diagnósticos e parâmetros acústicos. **Conclusão:** O treino auditivo potencializa as habilidades iniciais dos alunos, refinando-as para realização da avaliação, além de nortear ajustes em dinâmicas das disciplinas.

Correspondence address:
Marcia Simões Zenari
R. Cipotânea, 61, Butantã, São Paulo (SP), Brasil, CEP: 05360-160.
E-mail: marciasz@usp.br

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Research conducted at the Department of Physical Therapy, Speech-Language Pathology and Audiology, and Occupational Therapy, School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.
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(1) University Extension Course (Graduate Specialization in Speech-Language Pathology and Audiology), School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.
(2) Department of Physical Therapy, Speech-Language Pathology and Audiology, and Occupational Therapy, School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.

INTRODUCTION

Voice perceptual evaluation is a traditional resource used to evaluate voice quality and it depends on the evaluator's experience. It is relative to the hearing impression of adapted or deviated voices, and it is criticized due to subjectivity, inconstancy and terminological variety. However this kind of evaluation is yet a ruler procedure in world scenario[1,2].

Due to the above characteristics, perceptual analysis suffers influences that might modify its final product. Among them, the evaluator's degree of hearing training and the clinical expertise are highlighted, and these factors may be minimized using specific protocols.

In order to standard the perceptual hearing evaluation to glottis level the Japanese Society of Logopedia and Phoniatrics (JSLP) proposed the GRBAS scale[3]. This scale widely disseminated is used internationally by clinicians and researchers in diverse areas in which voice evaluation is applied once it is related to psychoacoustic, acoustic and physiologic aspects of voice[5-7]. The evaluation is performed using voice samples, usually sustained vowels, connected speech, and spontaneous speech; there is not a standard for this procedure at the original scale proposal.

GRBAS applicability in voice area is broad and involves all kinds of voice disturbances, independent of etiology[8-15]. It is a simple and fast evaluation method proposing the observation of five parameters: G (grade) – overall dysphonia grade; R – roughness, represented by hoarseness and harshness; B – breathiness; A – asthenia; S – strain. Each parameter is measured in four gradation levels: 0 – normal; 1 – mild; 2 – moderate; 3 – severe[4].

To use GRBAS scale effective and safely it is required a previous training in order to refine the evaluator's hearing capability, in order to allow the focus in the interest parameters[16,17]. Due to its characteristics the use of GRBAS scale may be trained during the Speech-Language Pathology undergraduate program. The student may potentiate his/her hearing ability to voice evaluation during training and the guided exposition to different adapted and deviated voice samples may enhance the shaping of inexperienced listener[18].

It is noteworthy the voice perceptual evaluation, this research focus, is supplemented by the acoustic and physiologic analysis in voice global evaluation.

The absence of researches proposing hearing training in voice evaluation to Speech-Language Pathology students justifies the interest in this research. The present research intended to verify, among the Speech-Language Pathology students, the impact of hearing training in voice perceptual analysis and its respective association with acoustic analysis and otolaryngology diagnosis.

METHODS

This is a longitudinal research with intervention program and revaluations. There was approval of the Ethics Committee of the School of Medicine of the Universidade de São Paulo – USP, under protocol number 0481/08. All the participants signed the informed consent term.

Participants were 17 second-year undergraduate students in Speech-Language Pathology from USP. The students performed the perceptual evaluation of 17 voices in different moments: before, during, and after hearing training using GRBAS scale.

The voice sample was prepared from routine recording of Speech and Language evaluations of voice disturbance patients from the Otolaryngology Ambulatory of *Hospital das Clínicas* from *FMUSP*. The deviated voices were obtained from the database of Speech-Language Pathology Voice Investigation Laboratory (*Laboratório de Investigação Fonoaudiológica em Voz*) which the responsible is the coordinator researcher of this research. Cases with diverse larynx diagnosis and different GRBAS parameters disturbances were selected. Twelve patients were selected of which three had roughness predominance, three breathiness, three asthenia, and three strain. Besides these voices, it was inserted three voices without deviation in voice quality and in larynx examination, selected among the professionals in Speech-Language Pathologists and Otolaryngologists hospital team. Two voices (one normal and other deviated) were repeated in order to allow the reliability test intra-evaluator, at total 17 voices.

Voice recording

To voice recording it was requested the emission of sustained vowel /a/ and the reading of CAPE-V[19,20] proposed sentences, since they belong to the ambulatory recording routine and allow the GRBAS analysis. The emissions were registered in a microcomputer Desktop Pentium II, Sound Forge 6.0 software, using a Sennheiser® headset microphone, PC-20 model, placed at five centimeters distance from participants' labial commissure. All recordings were made in a acoustically treated room and occurred at the same day the participants came to ambulatory to be undertaken to laryngoscope evaluation.

Voice perceptual analysis

Judges

To verify the students' agreement in the diverse training moments it was necessary to undertake the voice samples to three Speech-Language pathologists voice specialists' evaluation. Therefore, the evaluation of judges using GRBAS scale was obtained. The judges were selected by expertise of more than five years in voice area and having practical with using the scale.

The voices were presented to the judges in a silent room using speakers connected to the computer. The analysis was individual, after listening to each voice, without communication between the judges and without having access to the others evaluation. The voices were repeated according request. The agreement index inter judges was high (>0.80) from intraclass coefficient correlation. In disagreement cases, the evaluation common to two judges would be considered. There was not any case of disagreement between the three judges.

Students' analysis

Twenty four second-year undergraduate students in Speech-Language Pathology were selected. None of them had previous

training in voice perceptual analysis, once they would still take the Phonation and Phonation Disorders disciplines. It was adopted was exclusion criteria the absence to any of the evaluations, which occurred to seven students. Therefore, the final sample had 17 students, 15 female and two male.

At first meeting it was given an introductory class, presenting the GRBAS to the students from examples illustrating each parameter and each degree of disturbance. Next, the participants performed they first evaluation (EV1) from the prepared voice samples to the research. The 17 voices were presented in sequence, and each of them was repeated twice. The students had a spreadsheet in which they had to indicate, individually, the gradation of each parameter for each one of the voices.

The students performed other five evaluations in distinct moments: the second evaluation (EV2) occurred at the final of first semester of Phonation discipline, after five training sections; the third evaluation (EV3) occurred at the beginning of Phonation Disorders discipline, after three months of previous evaluation, period in which there was not training sections, since the students were having another mandatory discipline; the fourth evaluation (EV4) occurred at the end of Phonation Disorders discipline, after another four training sections. Therefore, there were nine training sections, in total.

Besides the above evaluations, another two occurred: one in which was associated the GRBAS data to acoustic measures and spectrogram analysis (EVAcoustic), performed after the 8th training involving this association; and another one, performed at the last day of Phonation Disorders discipline, when the students had access to the diagnosis of the patients before performing the evaluation (EVDiagnosis). The same procedures described according to the place and equipments used at the first evaluation were maintained at the all the others.

Hearing training

It was performed hearing training with the students that happened during the last 30 minutes of class in the previous mentioned disciplines. Trough training all the doubts presented by the students were answered by the researcher.

The full training program was composed by:

- 1st training – Roughness parameter emphasis. It was presented five voices predominantly roughness, arguing about the degree of deviation and differentiation between hoarseness and harshness. Each voice was presented three times.
- 2nd training – Resonator/articulator (filter) system aspects emphasis versus glottis source. It was presented eight voices with filter deviation, arguing about their specific characteristics versus deviation at glottis source.
- 3rd training – Two voices with the same classification in GRBAS analysis emphasis. It was proposed to analyze two voices with different diagnosis and same classification at the scale. The two cases discussed had the following classification $G_2R_2B_1A_0S_1$.
- 4th training – Strain and asthenia opposition emphasis. It was presented tow voices asthenia predominant and two voices strain predominant, followed by arguing about their characteristics and differences between them.
- 5th training – Continuation of opposition between strain and asthenia. It was again discussed the opposition between strain and asthenia, once the students had doubts about asthenia classification. It was used another six voices evidencing the parameters.
- 6th training – The four perceptual parameters differentiation emphasis. It was presented four voices, one with each parameter (roughness, breathiness, asthenia, and strain). In this training it was discussed the relationship between perceptual evaluation and patients' self-evaluation data, according to the request of the students in order to improve comprehension of the relationship of voice deviation and self-evaluation protocols (Analogue-visual scale, Voice Related Quality of Life, and Voice Handicap Index). It was emphasized different kinds of impact that a voice may result in, reinforcing voice evaluation multidimensionality.
- 7th training – Hearing refinement emphasis. Training using voices brought by the students. For this section it was previously requested the students to bring voices of their own interests to analysis and discussion. It was predominant the psychodynamic of deviated voices in the selected voices about the deviated glottis source. Besides the reinforcement in the scale parameters, this training reinforced the others aspects involved in phonation as well.
- 8th training – Voice perceptual and acoustic analysis emphasis. It was presented four deviated voices, each with one of GRBAS parameters predominance. From this the acoustic correlation of each voice was discussed. To automatically extraction of measures the PRAAT software was used, and to present and discuss the spectrograms it was used the Spectrogram software, version 16.
- 9th training – Hearing refinement with background noise emphasis. It was presented three deviated voices while playing background music. The students should comment their impressions about the voices based on GRBAS parameters.

Statistical analysis

The students' agreement index in each of the six evaluations was made by comparison to the judges' agreement established using the Friedman Test. In presence of differences, the Wilcoxon test was used to compare the evaluations in pairs.

From the agreement degree mean intra-evaluator in each evaluation and the agreement mean intra-judge, it was verified the agreement degree in each parameter and to all parameters together. Kappa Agreement Index was calculated to verify the agreement between the students' evaluations and the judges' evaluations. It was used this index classification according to the following criteria: values higher than 0.75 – excellent agreement; between 0.40 and 0.75 – regular to good; and lower than 0.40 – bad agreement[21]. To all the tests the significance level adopted was 5%.

RESULTS

Firstly, the data about the four main evaluations will be presented and compared (EV1, EV2, EV3, EV4) at tables 1 to

Table 1. Comparison between mean of students accuracy to the four evaluations

Analysed parameters	EV1 (%)	EV2 (%)	EV3 (%)	EV4 (%)	p-value
G – overall grade	69	63	69	62	0.093
R – roughness	49	36	32	34	0.001*
B – breathiness	46	42	39	38	0.395
A – asthenia	50	58	58	62	0.028*
S – strain	41	44	48	41	0.145
Total	51	49	49	47	0.200

* Significant values (p<0.05) – Friedman test

Note: EV1 = evaluation 1; EV2 = evaluation 2; EV3 = evaluation 3; EV4 = evaluation 4

3. Following it will be observed the data about the evaluations associated to acoustic analysis (EVAcoustic) and to larynx diagnosis (EVDiagnosis) (Tables 4 and 5).

Regarding the students' agreement mean it was possible to observe that in first evaluation there was a mean of 69% of agreement to overall grade and 46.5% of agreement to all the others parameters (RBAS). These values were considered agreement level between regular and good, according to Kappa Agreement Index. There was difference regarding roughness and asthenia trough the evaluations as the mean of agreement to roughness was decreasing inversely proportional to asthenia parameter (Table 1).

Due to the observed differences regarding roughness and asthenia parameters it was necessary to compare the evaluations in pairs (Table 2). To roughness it was found difference between EV1 (48.8% agreement mean) and the others, all with lower means, as EV3 with the lowest agreement mean (32.2%). Regarding asthenia the difference occurred between EV1 (50.2% mean of agreement) and EV4 (61.9% mean of agreement) (Tables 1 and 2).

Kappa Agreement Index was applied considering the mean of agreement intra-evaluator in each evaluation and the intra-judge mean of agreement. This analysis was performed to each parameter and to all the parameters by the overall mean. It was verified the higher index occurred between the G first evaluation and gold standard, with value of 56.3%, classified as regular to good (Table 3).

Comparing the first and last evaluation (EV1 and EV4) and the evaluations associated to acoustic analysis (EVAcoustic) and larynx diagnosis (EVdiagnosis) it was not observed difference regarding the diverse parameters, except to roughness. This founding point out to the difficult presented in the evaluations regarding roughness (Table 4).

Comparing the evaluation moments in pairs to roughness parameter it was found difference between EV1 (49% agreement mean) and EVAcoustic (39%), and EV1 and EVDiagnosis (27%), founding showing that this is the most complex parameter to evaluators analysis (Table 5).

DISCUSSION

Voice perceptual analysis is sovereign in clinical practice, specially because it translates reliably the aspects related to voice quality[21]. Although it is intuitive, subjective and depending on the evaluator experience, as well as the conditions of attention trough the process[2,16,23], it has been considered relevant to voice disturbances documentation[23].

Table 2. Roughness and asthenia parameters pair analysis in the four moments of evaluation

	Roughness			Asthenia		
	EV1	EV2	EV3	EV1	EV2	EV3
EV2	0.008*			0.062		
EV3	0.001*	0.348		0.135	0.892	
EV4	0.023*	0.622	0.789	0.027*	0.124	0.376

* Significant values (p<0.05) – Wilcoxon test

Note: EV1 = evaluation 1; EV2 = evaluation 2; EV3 = evaluation 3; EV4 = evaluation 4

Table 3. Kappa agreement index for intra-evaluators analysis regarding sutdents' agreement mean related to agreement mean of judges

		Kappa (%)	p-value
G	EV1	56.3	<0.001*
	EV2	47.2	<0.001*
	EV3	55.4	<0.001*
	EV4	45.4	<0.001*
R	EV1	30.2	<0.001*
	EV2	15.4	<0.001*
	EV3	12.7	<0.001*
	EV4	13.7	<0.001*
B	EV1	23.7	<0.001*
	EV2	18.7	<0.001*
	EV3	17.7	<0.001*
	EV4	16.6	<0.001*
A	EV1	13.1	<0.001*
	EV2	14.1	<0.001*
	EV3	13.9	<0.001*
	EV4	12.0	<0.001*
S	EV1	8.8	<0.001*
	EV2	13.6	<0.001*
	EV3	19.6	<0.001*
	EV4	7.5	<0.001*
All parameters	EV1	34.7	<0.001*
	EV2	31.3	<0.001*
	EV3	32.3	<0.001*
	EV4	29.1	<0.001*

* Significant values (p<0.05) – Kappa Coefficient

Note: EV1 = evaluation 1; EV2 = evaluation 2; EV3 = evaluation 3; EV4 = evaluation 4

Table 4. Comparison between students' agreement mean in initial and final evaluation and in evaluation involving acoustic analysis and larynx diagnosis

Evaluated parameters	EV1 (%)	EV4 (%)	EVAcoustic (%)	EVDiagnosis (%)	p-value
G – overall grade	69	62	66	50	0.157
R – roughness	49	34	39	27	0.043*
B – breathiness	46	38	45	45	0.670
A – asthenia	50	62	64	65	1.000
S – strain	41	41	42	43	0.168
Total	51	47	51	46	0.151

* Significant values (p<0.05) – Friedman test

Note: EV1 = evaluation 1; EV4 = evaluation 4; EVAcoustic = evaluation after acoustic training; EVDiagnosis = evaluation after larynx diagnosis training

Table 5. Roughness parameter pair analysis between initial and final evaluation, associating with acoustic analysis and larynx diagnosis

	Roughness	
	EVAcoustic	EVDiagnosis
EV1	0.021*	0.027*
EV4	0.711	0.168

* Significant values (p<0.05) – Wilcoxon Test

Note: EV1 = evaluation 1; EV4 = evaluation 4; EVAcoustic = evaluation after acoustic training; EVDiagnosis = evaluation after larynx diagnosis training

There are not researches evaluating which methods are more indicated to develop this abilities in Speech-Language Pathology students[24]. Therefore the current research searched for verifying the hearing training impact proposed to the second-year undergraduate students in Speech-Language Pathology throughout two voice area disciplines.

Regarding the obtained results it is noteworthy the initial students' agreement index considered from regular to good. It was observed that the basic learning of voice perceptual analysis using GRBAS scale the students reached results that might be considered expressive generally, with highlights to G parameter analysis (overall degree), that represents overall perception of evaluator regarding dysphonia and it has been showing itself the most reliable parameter of the scale[25]. These data suggest the learning of proposed evaluation may be considered relatively simple, once the Speech-Language Pathology students, without previous training, may present good results. Similar results were found in another research involving voice spectrographic analysis[17].

Regarding the roughness and asthenia parameters it was observed significant difference through the four main evaluations. The students' agreement index to roughness was lower in evaluations EV2, EV3, and EV4 comparing to EV1. It is believed in fact this parameter to be more complex, worked with the students from the first training in a segmented way in harshness and hoarseness, and this segmentation may have difficult the evaluation task. The students start to deal with more information which may had difficult the process when having few experience and knowledge as to voice quality as to the involved voice disturbances[17].

Literature points out to the complexity of roughness parameter and the controversies about itself, fact that corroborates the founding of this research[26]. The option to divide this parameter in hoarseness and harshness was based on national literature pointing several controversies regarding the translation of the roughness term. According to some authors[27], the R involves roughness concept, crepitating, bitonality, and also harshness, as these authors highlights the difficult in Brazilian reality to fit the deviations related to harshness, factor that is not favored in GRBAS scale. Others authors compared hoarseness, harshness, and normal voices using spectrographic acoustic analysis, pointing out marked differences between those voices[28]. Despite the justification related to the option made in this research, the founding point out to a difficult in distinguishing these terms by the students. Future researches may evaluate the performance of perceptual training of the same aspects associated to crepitating, and bitonality, as well as to evaluate the performance from a broader roughness concept.

It is noteworthy that the students themselves may not had a clear perception about this difficult, once they did not presented doubts regarding this parameter during the meetings.

As in asthenia case it was observed higher agreement means in EV4 related to EV1. As during training the students showed doubts regarding asthenia, this parameter was more explored in a higher number of meetings than firstly previewed. This data indicates that training may be more effective when there is a specific interest by the students. This is even more evident when observing the initial evaluation asthenia had been rightly analyzed by 50% of the students, similar initial index obtained by roughness, which results through training were quite different. It may be inferred, therefore, that the voice analysis refinement stimulated the learning of asthenia parameter.

It is known that the agreement inter and intra evaluator is an indispensable factor to reliability in voice perceptual analysis[29]. This agreement may be improved with expertise in deviated voices analysis and it is affected by factors as fatigue, lapses of attention, and misconceptions during evaluation[2,18,24]. It was verified in this research that the answers agreement intra-evaluators relating to the judges evaluation was significant to all the parameters; however, it is noteworthy that this significance may be direct related to size sample.

Regarding overall grade the index reached 0.56 representing

level of agreement from regular to good. At the other parameters the percentage indexes were lower than this value which may indicate probable learning curve.

Regarding voice perceptual evaluation performed in association with acoustic analysis data (automatic measurements and spectrogram), it was observed again difference in roughness, with worsening comparing to the initial evaluation. This result may be partially assigned to the increase of offered information, besides de complexity of roughness parameter, previously discussed[17,26-28] (Table 5). This data corroborates by the similar found associating voice perceptual analysis and physician diagnosis, once there was more difficult to analyze roughness in this task when compared to the first evaluation.

It is important to consider that the time reserved to hearing training was 30 minutes at the end of the class, and the students could be tired with troubles in focusing attention. Besides the number of dates may be high, as well as the number of evaluations, which may have discouraged them.

It was observed a higher interest and participation in the meeting that involved factors related to the presented cases: history, voice complaint, analogue-visual scale data, self--evaluation protocol results and voice related quality of life, and physician diagnose. Still many information about the cases were presented it was observed that training made the students to keep attention to clinical thinking that is emphasized.

It is noteworthy the initial performance of the students, considered regular/good, was higher than expected since they are listeners without previous experience to this kind of evaluation. This fact is even more evident when observing similar performances were found in researches with students with a little more of experience[30].

In the current research the obtained results point out to possible adjustments to be done in Phonation and Phonation Disorders disciplines, valuing the hearing comprehension, acoustic, and physiological of the involved parameters in voice perceptual analysis, specially to roughness parameter.

From this initial experience, adjustments are being done to reapply the training in a new group of students, condensing the training in six sequential sections during Phonation discipline (first semester) and, therefore, allowing an intensive and concentrated training. A training proposal in acoustic analysis may be incorporated in the second semester, complementing the voice evaluation student shaping.

The benefits came from the hearing and acoustic training justifies the search to an effective and efficient hearing training program, during the undergraduate or in graduate courses in Speech-Language Pathology. Are evidenced the gains, even partial ones, that hearing training may bring to the students regarding their ability to evaluate voices. Adjustments are going to be necessary to future trainings from the observed aspects. New researches may guide effective didactic to learning of the Speech-Language Pathology student regarding voice perceptual analysis.

CONCLUSION

Hearing training impact in Speech-Language Pathology students was positive, showing a satisfactory initial learning and different performance trough training according to GRBAS parameters.

This research suggests adjustments in future trainings. This initiative helped to guide the needed changes in the discipline dynamic with special attention and reinforcement to roughness parameter.

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