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Elaboration of an instrument to investigate the acquisition of minimal contrast perception in the Brazilian sign language

A elaboração de um instrumento para investigar o domínio da percepção dos contrastes mínimos na língua brasileira de sinais

Keywords

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ABSTRACT

Purpose: To design an instrument to check the perception of minimal contrasts by through pairs of signs, which differ in one the following parameters: handshape, hand location, hand movement and hand orientation. **Methods:** An inventory of minimal pairs was made and some pictures were drawn by a visual artist. These pictures were organized into three columns, which could be equal or different from each other in the pair. A video file with an interpreter making two signs at a time was played to the individual taking the test and this was expected to watch the signs and point to the pictures that corresponded to them. Raters analyzed the pairs and decided whether or not they were accurate. They could modify the pairs or ask for particular pairs to be removed; they also checked if the pictures were clear and if they were part of the children's vocabulary. **Results:** The analysis of agreement among raters had a significant result for the criterion rated as 'not a minimal pair'. Thus, 13 items were removed from the instrument because they differed as to more than one parameter, and were considered either analogous or not minimal pairs. Additionally, 16 pairs were modified, and seven pairs which differed in orientation, were added. As a consequence, there was a total of 35 minimal pairs in the final version of the instrument. **Conclusion:** The purpose of designing an instrument for evaluation of the perception of minimal contrasts was achieved. Some adjustments were made during the assessment of the content of the instrument as suggested by raters. The final instrument was composed of 35 pairs which differ from each other in only one parameter.

RESUMO

Objetivo: Elaborar um instrumento para verificar a percepção dos contrastes mínimos, mediante a utilização de pares de sinais, os quais apresentam oposições em relação um dos parâmetros: configuração de mão, locação de mão, movimento de mão e orientação de mão. **Método:** Realizou-se um levantamento dos pares mínimos e foram confeccionadas figuras por um profissional das artes visuais, essas foram dispostas em três colunas, podendo ser iguais ou diferentes. Realizou-se a gravação de um vídeo contendo uma intérprete que realizava dois sinais por vez, para que o sujeito que fosse ser avaliado pudesse visualizá-los e apontar nas figuras, quais os sinais foram solicitados. Os julgadores analisaram os pares, referindo se estavam adequados, podendo realizar modificações ou solicitar que o par mínimo fosse retirado. Os julgadores verificaram ainda se as figuras estavam claras e se eram do vocabulário de crianças. **Resultados:** A análise de concordância realizada entre os avaliadores mostrou resultado significativo para o critério julgado como 'não é par mínimo'. Foram retirados do instrumento 13 itens, pois variavam em mais de um parâmetro, configurando dessa forma, pares análogos e não pares mínimos. Foram modificados 16 pares, e acrescentados sete que variavam quanto ao parâmetro orientação, configurando um total de 35 pares mínimos na versão final do instrumento. **Conclusão:** O objetivo de elaborar um instrumento de percepção de contrastes mínimos foi alcançado, sendo realizados alguns ajustes necessários durante a avaliação de seu conteúdo pelos juizes. O instrumento final foi composto por 35 pares, os quais diferem em somente um parâmetro.

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INTRODUCTION

Children whose contact with Brazilian Sign Language (LIBRAS) started at birth develop this language naturally, without the need for formal education. Also, they reach stages of language development similar to those of children that have acquired an oral language⁽¹⁾. They start by making a single sign, followed by the first combinations, until they have reached the stage of multiple combinations. LIBRAS is a visual-spatial language, with the same levels as any natural language which manifests itself in the auditory-vocal channel: phonology, morphology, syntax, semantics and pragmatics^(2,3). It should be noted that sign languages do not prevent learners from acquiring an oral language, as long as they have the required auditory performance with the help of hearing aids⁽⁴⁾.

In oral languages, phoneme discrimination is important for the development of language, since phonemes are the smallest meaningful contrastive units. For such purpose, reception, organization and processing of auditory information are required for the storage of language representation^(5,6). Similarly, visual perception in LIBRAS is extremely important for storage of the signifier and the signified through perception of the sign so that production can occur subsequently. This is because these distinctive features are small parts that distinguish one sign from another and modify a concept, and even a context⁽⁷⁾.

In that visual-spatial language, soundless minimal units, which would be equivalent to phonemes/distinctive features, are called parameters, and they modify the entire composition of a sign⁽²⁾. These parameters are described below.

- Handshape: it is the shape of the hand while signing. It can be made through fingerspelling (hand alphabet) or other shapes made by the signer's dominant hand or by both hands;
- Point of articulation or location: refers to the location in signing space for movement of the dominant hand;
- Movement: it is a complex parameter, because signs can have hand-internal movements, wrist movements and movements through the signing space. In addition, there are signs that do not need movement;
- Orientation: refers to the direction that the palm of the hand points to while a sign is made; signs can follow a back-and-forth direction. They can signify the idea of opposition, contrariness or person-number agreement;
- Non-manual elements: they refer to body postures and facial expressions (face, eyes, head and torso). They refer to distinctions made between lexical items and sentence markers.

In the present study, non-manual expressions were not addressed because they usually convey emotions, which are difficult to represent in pictures. The literature reports the example 'theft' *versus* 'sexual act'. It is also noteworthy that non-manual expressions are used to mark interrogative sentences and relative clauses⁽⁷⁾.

These phonological parameters form signs and some of them form the so-called minimal pairs, which occur when two signs are

distinguished by modifying only one parameter⁽²⁾. As well as in oral languages, phoneme discrimination is crucial for language development; in LIBRAS, perception and production of details that modify the composition of a sign are extremely important for acquisition of such language. Therefore, it is of utmost importance to investigate how minimal contrasts are acquired in sign language. Although research in this field has increased, there are still themes in linguistics that need further research; for example, studies in the fields of phonology, morphology, syntax, semantics, pragmatics, as well as sociolinguistics⁽⁸⁾.

Using an instrument for language assessment can help capture how a given language works, i.e., it is easier to perform an in-depth, quantitative overall assessment. Thus, the use of a tool enables the identification of what is expected in the development of a language. An adequate diagnosis can be made and hence a treatment plan can be designed when needed, in order to perform a therapeutic intervention⁽⁶⁾.

In Brazil, the practice of instrument design is still not very widespread⁽⁹⁾. In addition, there are few instruments that measure aspects of Brazilian sign language from the perspective of users. Sometimes, assessment instruments are focused on oral language and hence deaf children's potential can lag behind that of hearing children^(1,10). Some instruments are being currently designed but they have not been completed yet. Therefore, the design of the instrument presented in this work is of paramount importance.

The purpose of this study was to design an instrument to check and assess the perceptual acquisition of minimal contrasts by means of minimal pairs, which differ as regards the following parameters: handshape, hand location, hand movement and hand orientation.

METHODS

This study was approved in advance by the Research Ethics Committee of the university of affiliation of the authors, under protocol number 245.207. In order to design the instrument for perception of contrasts, first an inventory was made of Minimum Pairs found in Brazilian Sign Language. This inventory was prepared by the researcher, as part of her doctoral dissertation. The inventory was made with the aid of online LIBRAS dictionaries and a trilingual illustrated Brazilian sign language encyclopedic dictionary⁽¹¹⁾.

Each minimal pair in the set must differ in only one parameter. The target lexical items were chosen while meeting the following criteria: they had to be present in children's vocabulary and they had to be easily represented in drawing. After word selection, a visual artist was hired to create the pictures representing these minimal pairs in order to make them easy to apply to children.

These pictures were arranged into three columns in picture cards for graphical representation. Each card contained a total of six pictures, two in each column. The pictures could be identical or different, depending on the column. This format, the application and arrangement of pictures was based on *The Boston University Speech Sound Discrimination Picture Test*⁽¹²⁾ as well as on the phoneme discrimination picture test proposed by Santos-Carvalho⁽⁶⁾.

Also, a video file was recorded where the order of minimal pair elicitation was standardized for the purpose of instrument application. This video was recorded by the Data Processing Center (CPD) of the university where the research was conducted. The videotaped signs were made by a professor in the Department of Special Education in the same university, who is also a Brazilian sign language interpreter.

The video was edited in order to show one minimal pair at a time. After watching each sign made by the professor, the child taking the test was expected to choose a response in the picture card in between the pauses made on the video by the examiner. The participants had been instructed to point to the corresponding sign on the picture card that had been made on the video. After that, they watched a new pair of signs. The signs were presented on the video in a random and alternate order; two identical or two different signs could have possibly been made by the professor.

After the instrument had been designed, its content was submitted to evidence validation. Therefore, a search was made on the Lattes Platform to select raters who were experts on the subject, fluent deaf and hearing LIBRAS signers, who were devoted to teaching and research in Higher Education Institutions and, hence, met the criteria of the research proposal. A total of 5 raters were invited to participate; however, a rater refused to participate in the study, hence there was a final sample of four raters. Later, the pictures and the video were sent to these four raters, who are described below.

- Rater 1 (R1) - Hearing person, speech-language therapist, professor with a master's degree and researcher, currently working in a school for the deaf; qualified Brazilian sign language interpreter;
- Rater 2 (R2) - Hearing person; BA in pedagogy; Phd in linguistics; native-like command of LIBRAS; has conducted research with the following themes: Brazilian sign language, sign language acquisition, bimodal bilingualism, heritage languages, education of the deaf, and sign language translation and interpretation;
- Rater 3 (R3) - Deaf, BA in pedagogy, master's degree in pedagogy; bilingual user of LIBRAS/Brazilian Portuguese; conducts research on the following themes: education of the deaf, LIBRAS, grammatical structure, bilingualism and visual communication;
- Rater 4 (R4) - Deaf, Specialist in Education, experience as a teacher of LIBRAS, bilingual user of LIBRAS/Portuguese, Education of the Deaf, Sign Writing.

A hearing collaborator, with training in speech-language therapist; has a doctoral degree and is a researcher, with experience in sign language; he was also involved in decisive judgments with regard to the instrument that had not been identified by the other raters. The collaborator did not participate in the analysis and initial judgement; therefore, he is not considered as a rater but rather as a collaborator, because some decisions were accepted after the initial analysis.

The raters allowed his participation in the study after he signed the Informed Consent Form, and after their consent, he participated in the evidence validation step, based on the content of the instrument; they checked whether the instrument included the proposed objectives and if the relevant criteria for this evaluation were addressed adequately.

In this way, the raters were given the list with the selected minimal pairs and the picture layout with blank space for them to make comments. By means of a protocol, they could assess whether a given minimal pair was appropriate or inappropriate as regards the variation of one single parameter. Also, they could make comments to explain the reason why they were suggesting that such pair should be removed from the instrument. In addition, the raters could make comments about the pictures: whether they were clear and/or were part of children's vocabulary.

Evidence validation by raters based on the content of the instrument

Initially, 41 pairs of pictures were compiled and sent to the raters for analysis. The instrument contained 17 pairs which differed in handshape; 14 which were different as to location and 10 whose difference was movement.

Together with the list of minimal pairs, the raters received the pictures designed by the visual artist as well as the video where the signs were presented. The raters could request adjustments in the pictures, or in the movements made on the video; they could ask for the sign to be made more neutrally/smoothly, and request the removal of a minimal pair from the instrument if it was not suitable, or accept the pair without any changes.

Each 'minimal pair' item was considered as approved when there was more than 80% consensus among raters. Moreover, after the evaluation of the raters, an agreement analysis was made by using the Kappa coefficient with a significance level of 5%, i.e., $P < 0.05$. A kappa value between 0 and 1 may be interpreted as follows: $K < 0.4$ as poor; $0.4 \leq K < 0.75$ as fair to good; $K = 0.75$ as excellent.

Pilot study

It should be noted that the instrument was applied to two groups, one group of deaf individuals and one group of CODA (children of deaf adults). However, these works are part of the doctoral thesis research of the researcher and are being published as separate articles. It is worth of notice that the responses in children aged 5 and older were more reliable.

RESULTS

After the analysis of the raters, 13 pairs were excluded because they are analogous pairs which differed in more than one parameter. In addition, after an initial analysis of the present work, seven pairs were added whose difference was the hand orientation parameter. These pairs had not been included at first. After the raters' analysis, the modifications and adjustments were submitted to agreement analysis performed statistically, whose results are shown in Table 1.

The results shown in Table 1 were statistically significant for the item ‘not considered as a minimal pair’. Although the correlation value is too weak, correlation for the item ‘not considered as a minimal pair’ with Kappa coefficient = 0.183 was a statistically significant result; therefore, these pairs were removed from the instrument.

In the final version, the instrument was composed of 35 pairs, 14 of which differed in handshape; six for location; eight for movement and seven for orientation.

Table 1. Results of the analysis of agreement between the raters for each minimal pair analyzed

Category	Kappa; P-value
Accepted without suggestions	Kappa=0.012 P=0.400
Request for adjustment in pictures	Kappa=0.045 P=0.176
Request for adjustment in the video - movement of the sign	Kappa=0.049 P=0.156
Request for adjustment in the video - to neutralize the execution of a sign	Kappa=0.054 P=0.132
Not considered as minimal pair - Suggestion for removal from the instrument	Kappa=0.183 P<0.001*

*The p-value for the Kappa coefficient of agreement with a significance level of 5% (p<0.05)

Chart 1. List of pairs that were removed from the instrument because they were not considered as minimal pairs

Number of application of the instrument List of Pairs	Judgment (raters)
4. Near - find	It is not a minimal pair, it differs in more than one parameter (R1/C1)
5. Near - discover	It is not a minimal pair, it differs in more than one parameter (R2/C1)
6. Find - discover	It is not a minimal pair, it differs in more than one parameter (R1/C1)
23. Ignore - lazy	It is not a minimal pair, it differs in more than one parameter (R1/R2)
25. Learn - love	It is not a minimal pair, it differs in more than one parameter (R1/R2)
27. Learn - hear	It is not a minimal pair, it differs in more than one parameter (R2/C1)
28. Love - orange	It is not a minimal pair, it differs in more than one parameter (R1/R2)
29. Love - hear	It is not a minimal pair, it differs in more than one parameter (R1/R2)
30. Hear - orange	It is not a minimal pair, it differs in more than one parameter (R2/C1)
31. Television - work	It is not a minimal pair, it differs in more than one parameter (R2/C1)
32. Lie - Friday	It is not a minimal pair, it differs in more than one parameter (R2/C1)
38. High heel - electricity	It is not a minimal pair, it differs in more than one parameter (R1/R2)
42. Look after - Look for	It is not a minimal pair, it differs in more than one parameter (R1/R2)

Abbreviations R1, R2 and C1 correspond to the rater that suggested the change

A descriptive summary of the analysis of the raters is discussed below, focusing only on the signs that received some comment or suggestion of change (Chart 1).

Signs 4 (near - find), 5 (near - discover), 6 (find - discover), 23 (ignore - lazy), 25 (learn - love), 27 (learn - hear), 28 (love - orange), 29 (love - hear), 30 (hear - orange), 31 (television - work), 32 (lie - Friday), 38 (high heel - electricity) and 42 (look after - look for) were excluded from the instrument because they did not form minimal pairs; thus, only the signs that have been approved by the raters remained in the instrument. These signs were excluded when two out of the three raters (R1, R2 or C1) pointed out that the signs changed in more than one parameter, and therefore were not a minimal pair (Chart 1).

With regard to pairs that differed in the handshape parameter, 5 out of the 14 pairs (Chart 2) were changed according to raters’ requests. Pairs 3, 9, 12, 17 and 18 were videotaped again so as to be considered minimal pairs. The signs must vary only in one parameter; thus, the signs identified previously were supposed to have precisely identical movements.

In item 3, the sign for “beige” was supposed to be made with linear motion, just like the contrasting element of the corresponding minimal pair “gray”. Item number 9, which also differs for handshape, had to be modified because of location. The reason was that the minimal pair had not been made in the same location and, thus, it did not differ in one single parameter only.

In minimal pair number 12, both signs were supposed to be made with a simple, unrepeated movement, while the signs for “light” and “sun” (item 17) were expected to have the same pattern of movement, i.e., they had to be made with the same

Chart 2. List of minimum pairs that differ in handshape, with modifications suggested by the raters

Minimal pair - before analysis by raters	Minimal pair - after analysis by raters	Judgment (rater)
3. Gray - beige	3. Gray - beige	Make the two signs with linear motion (R3)
9. Family - people	6. Family - people	Videotape it again, and monitor location: make sure the signs are made in equivalent locations (R2)
12. Cold - sad	9. Cold - sad	Make ‘cold’ without the compound sign, so that it can be considered as part of the minimal pair (R1)
13. Help - wait	10. Help - wait	Remove the use of the pronoun ‘I’ used in the execution of the two signs / Make the signs again in a more neutral manner (R2)
17. Light - sun	13. Light - sun	Adapt the pattern of movement on video (R2).
18. Green - purple	14. Green - purple	Make the two signs with circular motion (R2).

Abbreviations R1, JR and R3 correspond to the rater that suggested the change

movement. In pair 18, the two signs were supposed to be made with circular motion.

Item 13 also differs only in the handshape parameter. However, it had extra modifications, suggested by rater R2, as to the inflection of the pronoun ‘I’, which had been used in the execution of the sign in the first video recorded by the interpreter. Moreover, it has been suggested by one of the raters that sign 13 should be made in a more neutral manner, without so much emphasis on facial expression, because this could influence children’s choice of sign in the picture card. In this case, they could deduce what the sign was, because the interpreter’s facial expression could possibly help them identify the sign.

With regard to pairs that differed as to location (Chart 3), the raters requested that the movement of item 19 should be made in a circular manner and item 21 should performed again more accurately so that they would actually differ in only one parameter.

Chart 3. List of pairs which differ in location and received suggestions of change by the raters

Minimal pair - before analysis by raters	Minimal pair - after analysis by raters	Suggestion (rater)
19. Pink - purple	19. Pink - purple	Make the two signs with circular motion (R2)
21. Saturday - learn	21. Saturday - learn	Make the signs again with the same motion (R1/R2)
24. Bad luck - I’m sorry	19. Bad luck - I’m sorry	Make the signs again in a more neutral manner (R2)
26. Learn - orange	20. Learn - orange	Make the signs again in a more neutral manner (R2)

Abbreviations R1 and R2 correspond to the rater that suggested the change

Chart 4. List of pairs which differ in movement and were adapted out of extra requests made by the raters

Minimal pair - before analysis by raters	Minimal pair - after analysis by raters	Suggestion (rater)
33. Lend - look for	21. Lend - look for	Make the signs again in a more neutral manner (R2)
36. Dangerous - mother	23. Dangerous - mother	Make the signs again in a more neutral manner (R2)
37. Dangerous - yellow	24. Dangerous - yellow	Make the signs again in a more neutral manner (R2)
39. Play - high heel	25. Play - high heel	Make the signs again in a more neutral manner (R2)
40. Hot - quick	27. Hot - quick	Make the signs again in a more neutral manner (R2)
42. Wait - stop	28. Wait - stop	Make the signs again in a more neutral manner (R2)

Abbreviation R2 corresponds to the rater that suggested the change

Again, the raters suggested some modifications which do not refer to the parameters being assessed; however, they are important when making a given sign, because they could influence the children’s choice if they remained unchanged. Thus, items 24 and 26 should be made neutrally, without emphasis on facial expression, because it could help the children taking the test to make a decision, as can be seen in the last two rows of Chart 3.

With respect to pairs that differ in *movement*, the modifications requested by the raters were only extra adaptations which were not related to the movement parameter under analysis; however, they could influence children’s perception. Therefore, signs 33, 36, 37, 39, 40 and 42 were videotaped again while using less emphatic facial expressions, as shown in Chart 4.

It is noteworthy that the pairs that are distinguished as to orientation were added only after they were suggested by the collaborator; therefore, they had not been changed in the analyses made by raters R1, R2 and R3.

DISCUSSION

For design of the instrument proposed in this article, the selected pairs were sent to the raters for analysis of evidence validation, based on the content of the instrument and the way it was presented on video, whether they were relevant and if they were properly made, respectively.

In this way, each item ‘minimal pair’ item was considered as approved when there was more than 80% consensus among the raters, a percentage above the one used in protocol validation studies, in which at least 70% agreement is recommended⁽¹³⁻¹⁶⁾. Thus, when more than two raters stated that a particular item was not appropriate, this item was removed from the instrument.

After checking the consensus among the raters, another analysis was made in order to check if there was statistical correlation; the findings pointed to the item ‘not considered as a minimal pair’ as statistically significant. Although the value of agreement has been considered to be poor (Kappa coefficient = 0.183), this result was statistically significant, which reinforced the idea that the signs rated as ‘not considered as a minimal pair’ should be removed from the instrument, because they differed in more than one parameter. It is noteworthy that the parameter ‘hand orientation’ was added after the raters’ analysis. This was a limitation of the present study, which can be overcome later.

Previous studies have reported that for two signs to be considered as a minimal pair in a sign language, these signs can vary in only one parameter but they have to keep other distinctive features while the concept and meaning are changed between each other^{2,7}. Thus, some changes were suggested by the raters, as can be seen in Table 1, because for signs whose difference was the handshape parameter, for example, the other characteristics should be identical. Thus, for the item “Gray - Beige” to be considered as a minimal pair, both signs should be performed with linear motion because handshape was the varying parameter *per se*. The same analysis was performed for the items in Chart 3, which differed in location; therefore,

the other distinctive features - such as handshape, movement and orientation - should be equivalent.

In addition to the modifications relative to parameters, some extra modifications were requested, e.g. making signs in a more neutral manner, without emphasis on non-manual elements such as facial expressions. These non-manual elements could influence the perception of the individual that is being assessed. People often use this resource to communicate and to express themselves even in oral languages. Therefore, emphasizing non-manual elements while signs were made could facilitate individuals' perception when they were attempting to distinguish the signs⁽²⁾.

A battery of instruments has been designed to evaluate competency in reading and writing of the deaf population; researchers have pointed to the lack of validated and normalized instruments in Brazil for assessment of the deaf population⁽¹⁶⁾. Particularly, the instruments that compose such battery investigate issues relative to reading, writing, reading comprehension of phrases, and phonological awareness; however, they have not investigated the parameters of LIBRAS that could serve as a comparison to the present study^(10,17,18).

In this research, efforts were made for the distribution of pairs between the parameters to be as uniform as possible. However, it should be pointed out that children's vocabulary was also considered when choosing each sign, hence the distribution of signs was not completely uniform. The instrument contains a greater number of pairs that vary in terms of handshape. It should be emphasized that handshape allows more different options than location, orientation and movement, because LIBRAS has 46 types of handshapes⁽⁷⁾. In addition, they are signs that are probably present in children's vocabulary.

Importantly, the present work is meant to contribute to both clinical practice and scientific research, because it is crucial to develop instruments designed to assess the individual performance of individuals whose native is LIBRAS. It is known that assessment instruments are focused on oral language and, thus, deaf children's potential, when compared to that of hearing children, is under-evaluated^{2,10}.

In a study for adaptation of an instrument on quality of life into LIBRAS, the researchers found it difficult to make such adjustment. The authors reported limitations, because Brazilian Portuguese and LIBRAS are different languages, with different language expressions and structures⁽¹⁹⁾. Also, the authors of the battery of instruments that was used to evaluate the reading comprehension of the deaf individuals stressed that there is a lack of instruments for assessment of sign languages^(10,17,18).

Thus, the results found while designing the present instrument showed that the initial objective of this study, i.e., that of developing an instrument to check the acquisition of perceptual contrasts, has been achieved.

CONCLUSION

Based on the results presented in this study, an instrument was designed to assess the perception of minimal contrasts through the use of minimal pairs in LIBRAS. These pairs varied

in only one parameter: either handshape, hand location, hand movement or hand orientation.

After raters' analysis, the instrument was adjusted as needed: changes were made to the movements of the signs; movements were made in a more neutral manner; some movements were modified to reflect the pictures in the chart. Some items were removed, because there was an agreement among raters that certain pairs were not suitable because they differed in more than one parameter. As a consequence, the final version of the instrument consisted of 35 pairs.

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¹ The percentage of 78% of scientific articles is justified because it is an innovative subject, and most studies are performed in the area of oral languages; also, publications are usually made of theses, dissertations and books rather than scientific articles.

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Author contributions

DZV elaborated and developed the work, which is part of her doctoral thesis, researched national and international theoretical reference, collected, evaluated the data and presented the results; CLM actively participated in the elaboration of this work, suggested, proposed, oriented and evaluated the article to meet the criteria of scientific research and care for the correction of the Portuguese language, from the elaboration of the project until the conclusion of the study; TMK also actively participated, with suggestions, revision, collaborated with the confection of the work, assisted in the necessary adjustments to improve scientific data and textual correction.