Measuring the structural validity of two Nordoff-Robbins scales for a patient with Tuberous Sclerosis

Medição da validade estrutural de duas escalas Nordoff Robbins para um paciente com Esclerose Tuberosa

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ABSTRACT

Over the years, Music Therapy has focused on conducting several clinical studies to verify treatment efficacy. However, only in the last two decades the amount of studies have increased based on the validation of specific Music Therapy assessment instruments. The basis for validating these instruments has its origin in psychometry. Psychometry, in turn, has been influenced by a secular practice that it would be possible to make inferences about the population from an individual. However, studies show that the correct thing is to evaluate an individual several times in order to make an inference about him. Thus, in this study, an evaluation of a patient diagnosed with Tuberous Sclerosis, autism and mental disability was carried out in order to verify the structural validity of the two scales for this patient. The evaluations took place from 120 excerpts of video recordings of Music Therapy interventions. The "Child-Therapist Relationship in the Coactive Musical Experience Scale" and the "Musical Communicativeness Scale" were used as assessment instruments. Data analysis took place by testing different models of confirmatory factor analysis of items where the scales latent variables were analyzed. It was evident that for the analyzed patient, considering the 120 excerpts of the video recordings, the two scales showed confidence only
for the general latent variable, the interaction. This study contributes to rethink scales’ use. In addition, it contributes to other studies to be carried out on structural validity with other individuals, diagnoses, instruments and approaches.

**Keywords:** music therapy, child-therapist relationship in coactive musical experience scale, musical communicativeness scale, Tuberous Sclerosis.

**RESUMO**

Ao longo dos anos, a Musicoterapia tem se concentrado na realização de diversos estudos clínicos para verificar a eficácia do tratamento. Porém, apenas nas últimas duas décadas, houve aumento na quantidade de estudos baseados na validação de instrumentos específicos de avaliação em Musicoterapia. A base para a validação desses instrumentos tem origem na psicometria. A psicometria, por sua vez, foi influenciada por uma prática secular de que seria possível fazer inferências sobre a população a partir de um indivíduo. No entanto, estudos mostram que o correto é avaliar várias vezes um indivíduo para fazer uma inferência sobre ele. Assim, neste estudo, foi realizada uma avaliação de um paciente com diagnóstico de Esclerose Tuberosa, Autismo e Deficiência Mental a fim de verificar a validade estrutural das duas escalas para este paciente. As avaliações ocorreram a partir de 120 trechos de videografavações de intervenções musicoterápicas. Utilizaram-se como instrumentos de avaliação a "Escala de Relação Criança-Terapeuta na Experiência Musical Coativa" e a "Escala de Comunicabilidade Musical". A análise dos dados ocorreu por meio do teste de diferentes modelos de análise fatorial confirmatória de itens onde as variáveis latentes das escalas foram analisadas. Ficou evidente que para o paciente analisado, considerando os 120 trechos das videografavações, as duas escalas mostraram confiança apenas para a variável latente geral, a interação. Este estudo contribui para repensar o uso das escalas. Além disso, contribui para outros estudos a serem realizados sobre validade estrutural com outros indivíduos, diagnósticos, instrumentos e abordagens.

**Palavras-chave:** musicoterapia, escala de relação criança-terapeuta na experiência musical coativa, escala de comunicabilidade musical, Esclerose Tuberosa.

**1 INTRODUCTION**

Human Sciences as well Health Sciences are guided by a secular practice that can be made inferences about certain individual just using the estimative of the population. This practice is sustained by the assumption that it is technically correct to directly transpose information based on population to each individual from this population. This direct transposition is technically wrong, according the ergodic theorems, and the interested reader can read the works of Jelihovschi.

Psychometrics has influenced many areas of science, regarding the studies of validity and reliability of scales. Unfortunately, psychometrics is affected by the aforementioned secular practice and assumption, so, all it has known about the validity of the constructs in Human Sciences and Health Sciences are based on population, such as:

1. personality (Gomes, 2012a; Gomes & Gjikuria, 2017; Gomes & Golino, 2012a),
2. intelligence (Alves, Gomes, Martins, & Almeida, 2016, 2017, 2018; Golino & Gomes, 2019; Gomes, 2010b, 2011b, 2012b; Gomes & Borges, 2007, 2008b, 2009b, 2009c; Gomes, de Araújo, Ferreira & Golino, 2014; Gomes & Golino, 2012b, 2015; Muniz, Gomes, & Pasian, 2016; Valentini et al., 2015),
3. academic achievement (Gomes, Golino, & Peres, 2016, 2018, 2020).
4. socioeconomics variables (Gomes & Almeida, 2017; Gomes, Amantes & Jelihovschi, 2020; Gomes, Fleith, Marinho-Araujo, & Rabelo, 2020; Gomes & Jelihovschi, 2019; Gomes, Lemos, & Jelihovschi, 2020),
5. metacognition (Golino & Gomes, 2014a; Golino, Gomes, & Andrade, 2014; Gomes & Golino, 2014; Gomes, Golino, & Menezes, 2014, Pazeto, Dias, Gomes & Seabra, 2019, 2020),
6. approaches to learning (Gomes, 2010c, 2011a, 2013; Gomes, Araujo, & Jelihovschi, 2020; Gomes & Golino, 2012c; Gomes, Golino, Pinheiro, Miranda, & Soares, 2011; Gomes & Linhares, 2018; Gomes, Linhares, Jelihovschi, & Rodrigues, 2021; Rodrigues & Gomes, 2020),
7. students' beliefs on teaching-learning processes (Alves, Flores, Gomes & Golino, 2012; Gomes & Borges, 2008a),
8. learning styles (Gomes, Marques, & Golino, 2014; Gomes & Marques, 2016),
9. motivation for learning (Gomes & Gjikuria, 2018),
10. academic self-reference (Costa, Gomes, & Fleith, 2017),
11. precognition (Gomes & Jelihovisch, 2016),
12. self-regulatory constructs and mediated processes (Cardoso, Seabra, Gomes, & Fonseca, 2019; Dias et al., 2015; Golino, Gomes, Commons & Miller, 2014; Gomes, 2007, 2010a; Gomes & Borges, 2009a; Gomes, Golino, Santos, & Ferreira, 2014; Pereira, Golino, M. T. S., & Gomes, 2019; Pires & Gomes, 2018; Reppold et al., 2015; Ricci, Gomes, Nico, & Seabra, 2020).

Despite music therapy has been influenced too by the commented secular practice and assumption, music therapy has its root in the clinical context and a practice of evaluating the individual so many times, since the process of the clinics demands this assessment for the evaluation of the therapy and progress of the patient (André, Gomes, & Loureiro, 2016, 2017, 2020a, 2020b; Rosário, Gomes, & Loureiro, 2019; Sampaio, Loureiro, & Gomes, 2015). This context is proper for the measurement of the individual, since a main condition for the estimative of the individual is the measurement of the person many times. The correct measurement of the individual requires that the construct be estimated based on the own individual. This measurement is based on the own variance of the person, that is, the intraindividual variance, which can be collected only if the patient performs a task repeated times. Technical details of the measurement of the individual are present in the works of Jelihovschi and Gomes (2019), as well as, Gomes et al. (2018).

In this study, we will present the analysis of an individual in the music therapy setting measured by two instruments, that is, “Child-Therapist Relationship in Coactive Musical Experience Scale” and “Musical Communicativeness Scale”. These scales were developed by Nordoff and Robbins (2007) in research initiated in partnership with the University of Pennsylvania. Currently, these scales have been used in several countries to assess people with different diagnoses such as: autism, childhood schizophrenia, severe emotional disorder, brain injury, mental impairment, Tuberous Sclerosis,
visual impairment, severe physical impairment, cerebral palsy, Down syndrome, learning disability with aphasia complications, anorexia nervosa and healthy people (Andre, Gomes & Loureiro, 2018; Bergmann et al., 2015; Bunt, 2003; Caltabiano, 2010; Carpente & Aigen, 2019; Cripps et al., 2016; Mackinlay & Forrest, 2011; Mahoney, 2010; Nordoff & Robbins, 2007; Robarts, 2000; Spiro et al., 2017; Szweda, 2015; Wood, 2006). By considering Brazilian context, these scales have undergone studies of translation into Portuguese, validation and reliability (André, 2017;2021; André, Gomes & Loureiro 2017, 2018, 2019, 2020c, 2020a, 2020b; 2022) and have been used as assessment tools in several research (André, Gomes & Loureiro 2020b, 2020a; André & Loureiro, 2019a, 2019b; Freire, 2014; André & Lopes, 2022; Sampaio, 2015).

The objective of this study is to measure the structural validity of the “Child-Therapist Relationship in Coactive Musical Experience Scale” and the “Musical Communicativeness Scale” in the evaluation of music therapy sessions performed with a teenager diagnosed with Tuberous Sclerosis, by evaluating validity structural of these two scales related to this patient as well as estimating the parameters of this individual.

2 METHOD
2.1 PARTICIPANTS

The participant, which was named in this article as B, or patient B, was 14 years old at the time of the recording videos used in this research. He was diagnosed as having tuberous sclerosis, autism and mental disability. At the beginning of the interventions, B communicated in a fragmented way with the music therapist and showed difficulties in attention, which interfered with the interaction. The music therapy objectives were to stimulate attention and increase interaction. The activities carried out in the interventions consisted of singing, moving parts of the body, playing musical instruments, following an instrument with the eyes, repeating rhythmic cells and immediate response. In this context, the interventions were organized in different activities, where at each moment B should focus attention on a specific objective. During the interventions, patient B
improved his attention and interaction with the music therapist. The approach used to care B was Neurological Music Therapy.

Neurological Music Therapy aims to promote the rehabilitation of sensory-motor, cognitive and language skills through the use of musical stimulus and its relationship with brain functions. It is based on the Rational Scientific Mediating Model (R-SMM), which considers music as a mediating ascension to achieve non-musical goals. (Thaut, 2005; Thaut & Hoemberg, 2014). The practice of neurological music therapy is based on the Transformational Design Model, which determines that the music therapist must know the patient's diagnosis, develop goals, carry out the functional design of non-musical exercises, translate these exercises into functional musical experiences and help the patient to transfer this learning for activities of daily living. This approach was used because it covers the care of various pathologies for both, early stimulation and rehabilitation including cases of Tuberous Sclerosis (Rosário, 2015).

In this study, videos from two music therapy sessions were used, the first and the last was performed with one semester apart. The videos were cut into 30-second temporal units, totaling 120 sections. Subsequently, one of the researches in this study evaluated each of the 120 excerpts of the interventions through the “Child-Therapist Relationship in Coactive Musical Experience Scale” and the “Musical Communicativeness Scale”.

An Informed Consent Form, allowing to recording music therapy sessions and the use of video recordings was signed by the patient’s B caregiver. This research was approved by University Ethics Committee and is registered under the number 04167218.2.0000.5149.

2.2 MEASURES

It was used as measurement instruments, the "Child-Therapist Relationship in Coactive Musical Experience Scale" and the "Musical Communicativeness Scale". For this study, the versions translated into Brazilian Portuguese by André, Gomes and Loureiro (2017, 2020a) were used.
The first scale, “Child-Therapist Relationship in Coactive Musical Experience Scale” consists of two domains: Levels of Participation domain (NP – Níveis de Participação) that allows the assessment in seven degrees of patient participation and the Quality of Resistiveness domain (QR – Qualidade de Resistividade) allows to evaluate in seven degrees the resistivity of the patient during the interventions. On this scale, grade 1 represents the least suitable behavior and grade 7 represents the best possible behavior.

More information about the English version of this scale can be found in the studies by Nordoff and Robbins (2007). The information about the Portuguese version of this scale can be found in the studies by André, Gomes & Loureiro (2020a). An explanation of the items evaluated in each domain of this scale can be seen in figure 1.

Figure 1: Explanatory scheme of items in the "Child-Therapist Relationship in Coactive Musical Experience Scale".

<table>
<thead>
<tr>
<th>Child-Therapist Relationship in Coactive Musical Experience Scale</th>
<th>Levels of Participation (NP)</th>
<th>Qualities of Resistiveness (QR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Stability and confidence in interpersonal musical relationship.</td>
<td>7. Through identification with a sense of accomplishment and well-being resists own regressive tendencies.</td>
<td></td>
</tr>
<tr>
<td>6. Mutuality and co-creativity in the expressive mobility of music.</td>
<td>6. a) Crisis-toward resolution. b) No resistiveness</td>
<td></td>
</tr>
<tr>
<td>4. Activity relationship developing.</td>
<td>4. Perversity and/or manipulativeness.</td>
<td></td>
</tr>
<tr>
<td>3. Limited responsive activity.</td>
<td>3. Evasive defensiveness.</td>
<td></td>
</tr>
</tbody>
</table>

The second scale, “Musical Communicativeness Scale” is composed of 3 domains: Instrumental Musical Communicability (IN - Instrumental), Vocal Musical Communicability (VO - Vocal) and Musical Communicability through Body Movements (MV- Movimento Corporal). Similarly, to the previous scale, this scale also contains seven degrees. In this scale, grade 1 represents no musical communication and grade 7 represents the best possible musical communication.
More information about the English version of this scale can be found in the studies by Nordoff and Robbins (2007). More information about the Portuguese version of this scale can be found in the studies by André, Gomes & Loureiro (2017). An explanation of the items evaluated in each domain of this scale can be seen in figure 2.

Figure 2: Explanatory scheme of items in the “Musical Communicativeness Scale”.

<table>
<thead>
<tr>
<th>Musical Communicativeness Scale</th>
<th>Instrumental (IN)</th>
<th>Vocal (VO)</th>
<th>Body movement (MV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Musical intelligence and skills freely functioning and competently, personably communicable. Enthusiasm for musical creativity.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Sustaining of directed response impulses setting up musical communication. Musical motivation appearing. Involvement increasing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Evoked responses (i): fragmentary, fleeting.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. No musically communicative responses.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3 PROCEDURES AND DATA ANALYSIS

Initially, it was planned to test two models using the confirmatory factor analysis of items. The first model assumed that the first two categories were explained by a latent variable corresponding to the measure of the “Child-Therapist Relationship in Coactive Musical Experience Scale”. This latent variable consists of the interaction between the patient and the music therapist. Although this interaction occurs during interventions, the focus of the assessment is not related to what the patient produces musically. In addition, this model assumes that the last three categories are explained by a latent variable representing the measure of the “Musical Communicativeness Scale”. The latent variable observed in this scale is musical communication through musical instruments, vocalizations or movements with the body. These two latent variables are correlated. The second model is identical to the first model but assumes the presence of a general factor (interaction) which explains the
variance of the five categories. In this model, all the variables are orthogonalized in a bifactorial structure. Since the first latent variable has only two observable variables, i.e. NP an QR, these loadings were fixed to be equal between themselves.

Secondly, it was planned that the model which had the best data fit would be selected to compose the third model. The third model would be identical to the selected model, but it added parameters considering that the patient’s performance is explained by his immediate previous performance.

The item confirmatory factor analyzes as well the Mardia test of multivariate normality were performed through the semTools R package (Jorgensen, Pornprasertmanit, Schoemann, & Rosseel, 2020). The data fit of the models was assessed by the Comparative Fit Index (CFI) and the Root Mean Square Error Approximation (RMSEA). CFI values equal or above .90 as RMSEA values smaller than .10 indicated that the model should not be refuted. The non-refuted models were compared through the chi-square and degree of freedom difference.

3 RESULTS AND DISCUSSION

The descriptive statics of the five categories of the “Child-Therapist Relationship in Coactive Musical Experience Scale” and “Musical Communicativeness Scale” can be seen in table 1. The first two categories come from the first scale while the last three categories pertain to the second scale. As it can be seen, the response of the patient was more heterogeneous in certain categories, such as the category IN. This category demonstrates that patient B presented variation between grades 1 and 6, ranging from no musical communication to stability of musical communication with independence in use rhythmic. The NP category was the most homogeneous, considering the patient’s responses range. Grade 4 in this category means partially participating in the activities and grade 7 means that the participation in the activities occurred in a stable manner, with mutuality and trust with the relationship between patient and music therapist.
Table 1 shows the skew and kurtosis of the univariate distribution. The QR category seems to have a non-normal distribution. We could not calculate the Mardia Test because the high frequency of missing data in certain variables. Missing data represents 27.67% of the patient’s scores. While the categories NP and QR do not carry any missing data, IN obtain 32.5%, VO 37.5% and MV obtain 68.33% of missing data. The characteristics of the music therapy intervention applied in the patient B was the cause of all missings data. Considering that when the music therapist demanded the patient to produce a VO answer, at the same time the music therapist did not demand the patient to produce a MV answer, so these variables did not carry covariance. Furthermore, they had to be eliminated of the analysis. Regarding only the variables NP, QR and IN, they showed a non-normal multivariate distribution, according the Mardia Test (Mardia Skewness: \( z = 224.94 \), p-value = 9.88e-43; Mardia Kurtosis: \( z = 10.02 \), p-value = 0). So, the maximum likelihood robust was used in the item confirmatory factor analyzes.

<table>
<thead>
<tr>
<th>Descriptive Statistics of the Five Categories</th>
<th>mean</th>
<th>sd</th>
<th>se</th>
<th>min</th>
<th>max</th>
<th>skew</th>
<th>kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>5.30</td>
<td>0.81</td>
<td>0.07</td>
<td>4</td>
<td>7</td>
<td>-0.49</td>
<td>-1.13</td>
</tr>
<tr>
<td>QR</td>
<td>6.47</td>
<td>0.59</td>
<td>0.05</td>
<td>3</td>
<td>7</td>
<td>-1.58</td>
<td>7.30</td>
</tr>
<tr>
<td>IN</td>
<td>4.88</td>
<td>1.12</td>
<td>0.12</td>
<td>1</td>
<td>6</td>
<td>-0.86</td>
<td>1.17</td>
</tr>
<tr>
<td>VO</td>
<td>2.89</td>
<td>1.64</td>
<td>0.19</td>
<td>1</td>
<td>6</td>
<td>0.11</td>
<td>-1.50</td>
</tr>
<tr>
<td>MV</td>
<td>3.74</td>
<td>1.46</td>
<td>0.24</td>
<td>1</td>
<td>6</td>
<td>-0.16</td>
<td>-0.77</td>
</tr>
</tbody>
</table>

Considering that two categories had to be deleted, only one model was tested. This model assumes that the NP, QR, and IN categories are explained by a general latent variable named as interaction, that represents the interaction between the patient and the music therapist. Because this model carries zero degree of freedom and any other model can be analyzed only in the presence of positive degree of freedom, the residual of the QR variables was constrained to be zero, so the model could present one degree of freedom. This model had an excellent data fit ($\chi^2 [1] = 0.24$, CFI = 1.000; RMSEA = .000, RMSEA CI lower = .000, RMSEA CI upper = .231). The loadings of the general latent variable on NP, QR and IN were .899, 1.000, and .838, respectively, indicating that these
categories are strong markers of the interaction between the patient and the music therapist.

The general latent variable contained an omega of .90 and an alpha of .87, indicating a high reliability of the scores. In sum, for this patient and considering the 120 video excerpts, both the scales measure a general factor, i.e. interaction, which represents the interaction between the patient and the music therapist.

Figure 3 shows the score of the patient in the general latent variable. Thirty-nine rows containing missing values were removed from figure 3. It is remarkable that the score of the patient was negative in the first 60 video excerpts, which represented the first session, while the following videos, which represented the last session, had, in majority, positive scores. This indicates that, very probably, the music therapy sessions were effective to improve the general latent variable, i.e. his interaction with the music therapist.

Figure 3. Score of the Patient in the General Latent Variable of Interaction between the Patient B and the Music Therapist.
Figure 3 shows that there was improvement of patient B when comparing the first and the last session of intervention. In the first session of the semester, patient B participated in what was proposed by the music therapist in a fragmented way. Although he was able to move around and vocalize, he found it difficult to focus attention on what the music therapist requested. In this way, he sang and played only small parts of music and soon became distracted, failing to complete the activity. In the last intervention, patient B sang or played only as requested but talked and interacted with the music therapist throughout the session. This shows that there was an improvement in attention, which reflected in the quality of participation in activities and the degree of interaction with the music therapist by using a systematic intervention.

It became evident in this study, that the “Child-Therapist Relationship in the Coactive Musical Experience Scale” and the “Musical Communicativeness Scale” were considered valid for the evaluation of patient B, in terms of measuring a general factor of interaction. Gomes, Araujo, Nascimento and Jelihovschi (2018) describe how much the validation of a test to assess an individual can be complex. Thus, they clarify that only the application of tests several times with the same individual, by capturing the variance, can allow the individual to be estimated. Several studies have shown that the “Child-Therapist Relationship in Coactive Musical Experience Scale” and the “Musical Communicativeness Scale” have been used more frequently over the years to assess individuals with different diagnoses (Andre, Gomes & Loureiro, 2018; Bergmann et al., 2015; Bunt, 2003; Caltabiano, 2010; Carpente & Aigen, 2019; Cripps et al., 2016; Freire, 2014; Mackinlay & Forrest, 2011; Mahoney, 2010; Nordoff & Robbins, 2007; Robarts, 2000; Sampaio, 2015; Spiro et al., 2017; Szweda, 2015; Wood, 2006). This fact demonstrates that these scales have been well accepted by several music therapists around the world in the clinical and research contexts.

The literature reports that scales have shown positive results in several approaches to music therapy, in addition to presenting good inter-examiner reliability and good correlations with other measuring instruments, such as “Childhood Autism Rating Scale”, the “Autism Treatment Evaluation Checklist”
and the “Improvisational Assessment Profiles” (Andre et al., 2018). As stated by the authors Nordoff and Robbins (2007), a small improvement in the degree scored in the patient's assessment can be as important as a larger difference in scores in another patient. This reinforces the need to always develop studies taking into account the peculiarities of each individual, as well as what would be the most appropriate assessment tool for them.

4 CONCLUSION

This study has shown that in Music Therapy, most of the validation research on assessment instruments is recent, dating mostly from the last twenty years (Waldon & Gattino, 2018). However, studies of music therapy aiming at analyzing the structural validity of assessment instruments based on the individual are still scarce. In this study, when verifying the “Child-Therapist Relationship in the Coactive Musical Experience Scale” and the “Musical Communicativeness Scale”, good results were found in the general latent variable of the scales analyzed. It was found that patient B showed considerable improvement for interacting with the music therapist between the sessions, which shows that Music Therapy provided positive gains.

Music therapy intervention applied in the patient B were systematically organized and conducted into specific activities that demanded certain behaviors in each activity. This systematization, in given moments, has not demanded vocal musical communication or musical communication through body movements. Due to this fact, categories VO and MV in the “Musical Communicativeness Scale” had no covariance and analyzes were carried out in the IN category of the “Musical Communicativeness Scale” and in all categories of the “Child-Therapist Relationship in the Coactive Musical Experience Scale”. Indeed, the case of patient B, the systematic music therapy approach allowed activities to be more balanced among all musical communication options evaluated by the "Musical Communicativeness Scale". However, the choice of the music therapist for that intervention there were few activities that could be analyzed in the VO and MV categories. This implies that, in certain types of interventions, where there is an
imbalance in the proportions of activities that allow different types of musical communication, some categories of the "Musical Communicativeness Scale" may not be considered to analyze the parameters of the individual.

The study shows that those scales were considered valid and reliable for patient B only in terms of the general factor, that is, interaction. In other words, the two scales do not measure what they intend to measure, but measure a single general factor, the interaction.

The results obtained in this study reinforce the proposal of the authors Nordoff and Robbins (2007) that the scales should be used together. According to the authors, the scales are complementary in the assessment of the patient. For future studies, the possibility of transforming these two scales into one is suggested, considering its general latent variable. Those results are innovative, since studies with this type of analysis for these scales were not found in the literature. It would be interesting to rethink the scales considering new possibilities for interpretations. It is expected that this study will contribute to new research on structural validity by using other individuals diagnoses.
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