Game Behavior Scale–Electronic (GBS-E): elaboration and psychometric evidence

Ana Karla Silva Soares[1] , *Maria Celina Ferreira Goedert*
Federal University of Mato Grosso do Sul, Campo Grande-MS, Brazil
Tailson Evangelista Mariano
Catholic University of Pernambuco, Recife-PE, Brazil

ABSTRACT

Despite the growing engagement in electronic games globally and the need to measure behavior in this context, there are few instruments for this purpose. The present study aimed to develop and validate the Game Behavior Scale–Electronic (GBS-E) in Brazil. In Study 1 ($N=409$), exploratory factor analysis supported the adequacy of a two-factor solution (individual and collective behavior). In Study 2 ($N=373$), we used confirmatory factor analysis, item response theory (to evaluate the discrimination and difficulty levels), and graphical factor analysis to test the above version of the scale and propose a short form of the GBS-E. The results suggest that both forms (full form, 31 items and short form, 10 items) of the GBS-E demonstrate psychometric evidence (factorial validity and internal consistency) for the adequacy of the measure to evaluate individual and collective behavior in electronic games.
Keywords: behavior; electronic sport; players; factor analysis; psychometrics.

RESUMO – Escala de Comportamento em Jogo – Eletrônico (ECJ-E): Elaboração e evidências psicométricas

Apesar do avanço da prática do esporte eletrônico a nível global e da necessidade de mensurar comportamentos neste contexto, são escassos na literatura instrumentos para este fim. Assim, o presente estudo objetivou elaborar e validar a Escala de Comportamento em Jogo – Eletrônico (ECJ-E) em uma amostra brasileira. No Estudo 1 ($N=409$) uma análise fatorial exploratória suportou a adequação de uma solução bifatorial (comportamento individual e coletivo). No Estudo 2 ($N=373$), utilizou-se de análise fatorial confirmatória, da Teoria de Resposta ao Item (para avaliar os níveis de discriminação e dificuldade) e da análise fatorial gráfica para testar a versão do estudo anterior e propor uma forma curta da ECJ-E. Os resultados sugerem que tanto a forma completa (31 itens) quanto a curta (10 itens) da ECJ-E fornecem evidências psicométricas (validade fatorial e consistência interna) de adequação da medida para avaliar o comportamento individual e coletivo em jogo – eletrônico.
Palavras-chave: comportamento; esporte eletrônico; jogadores; análise fatorial; psicometria.

RESUMEN – Escala de comportamiento en el juego – Electrónico (ECJ-E): Elaboración y evidencias psicométricas

A pesar del avance de los deportes electrónicos a nivel mundial y la necesidad de medir comportamientos en este contexto, los instrumentos para tal fin son escasos en la literatura. El presente estudio tuvo como objetivo desarrollar y validar la Escala de Comportamiento en el Juego - Electrónico (ECJ-E) en una muestra brasileña. En el Estudio 1 ($N=409$), un análisis factorial exploratorio apoyó la idoneidad de una solución de dos factores (comportamiento individual y colectivo). En el Estudio 2 ($N=373$), utilizamos el análisis factorial confirmatorio, la Teoría de la Respuesta al Ítem (para evaluar los niveles de discriminación y dificultad) y el análisis factorial gráfico para probar la versión del estudio anterior y proponer un formulario breve. Los resultados sugieren que el formulario completo (31 ítems) y el breve (10 ítems) del ECJ-E aportan evidencias psicométricas (validez factorial y consistencia interna) de la adecuación de la medida para evaluar el comportamiento individual y colectivo en los juegos electrónicos.
Palabras clave: comportamiento; deporte electrónico; jugadores; análisis factorial; psicometría.

In recent years, the electronic games industry has achieved wide visibility on the world stage, encompassing people of different age groups and goals, from children playing for recreational purposes to young people and adults who dedicate themselves to professional activity. In general, e-sports can be understood as games played through a computerized interface (Goedert & Soares, 2019; Hamari & Sjoblom, 2017). There are international organizations and entertainment channels that broadcast their competitions, emphasizing the relevance achieved by e-sports.

With the importance and ubiquity e-sports have acquired in everyday life and the formulation of theories from common sense about its effects on the lives

of its players, discussions in the academic sphere on the psychological impact of their practice have expanded. Such research has mostly focused on negative aspects, such as addictive behaviors and psychological disorders (Pérez-Rubio et al., 2017; Triberti et al., 2018). Still, there are a growing number of studies that also aim to highlight their potential benefits to physical and psychological health (Coser & Giacomoni, 2019; Lobel et al., 2017), which have emphasized the need for adequate instruments to measure specific variables in this context.

Scholars of sports emphasize that one of the most important dimensions to understand is behavior (Kavussanu & Boardley, 2009), which is defined in psychology in both broad and specific ways but can be conceptualized as an action that will resonate in other actions of other individuals, either directly or indirectly, creating a network of interdependent and interrelated interactions (Tourinho, 2006). Thus, thoughts and emotions also go into the behavior of a subject, albeit in the sense of creating an expectation about an event (Rodrigues et al., 2018). Studies that permeate the way in which the individual carries out and modifies a behavior (pro- or antisocial) are evident, even in game environments (Azeredo et al., 2019; Shliakhovchuk & Muñoz García, 2020).

In e-sports, as in physical sports, there are situations in which behavior is important to investigate the performance of those who practice it, as well as strategies to deal with situations inside and outside the game (Pikos & Straub, 2020; Spruit et al., 2019) involving physical and psychological dimensions (Adinolf & Turkay, 2018; Matsui et al., 2020). However, the published studies have offered no quantitative instruments to empirically evaluate the nature of the behaviors performed in the context of e-sports.

On this background, seeking to understand how behavior can be related to the psychological issues of individuals in the e-sports context, we took psychological theories developed by Hofstede (1980) and Triandis (1994) as a starting point. According to Hofstede (1980), the individual will fit into a concept of polarization regarding their social behavior, acting according to the individual or collective elements that are placed in their culture. Triandis (1994) shows a plural formation of the individual, in which, regardless of the conception existing in a given culture, there will be individuals who prioritize more individual and more collective traits.

A similar study was conducted by Melo and Giavoni (2010), who started from the psychological concepts of individualism–collectivism and sought to differentiate athletes into identity categories called idiocentric and allocentric. The first describes the athlete who has more individualistic characteristics, with greater emotional detachment and with personal goals above those determined by the group. The latter are those who prioritize interpersonal relationships and the harmony of the group and focus their efforts on the good of the collective. The dimensions of individualism and collectivism are associated with the characteristics of the sports players (Melo & Giavoni, 2010). Thus, these concepts can serve as a basis for understanding both psychological profiles and to promote the analysis of behaviors within the context of the game, specifically, electronic games.

A recent search of the Google Scholar (2021), Index Psi (2021), and SciELO (2021) databases, using the key expressions "electronic sport", "behavior", and "scale", both in English and in Portuguese, highlighted that there is still no Brazilian (or international) instrument to specifically evaluate the behaviors characteristic of e-sports players. The research conducted on such behaviors has not entered the empirical field of instrumentalizing the measurement of this dimension in this group of individuals. However, studies that analyze behaviors in the context of physical sports, centered on dimensions and modalities, do exist. For example, an analysis of leadership behavior in handball (Simões, 1994), an analysis of basketball based on the theory of behavior analysis (Cillo, 2002), and an evaluation of prosocial and antisocial behaviors (Kavussanu & Boardley, 2009) in general physical activities have been conducted. There are a range of instruments that evaluate specific behavioral aspects, such as the Sports Coaching Behavior Scale (CBS-S, Jain et al., 2018) and Pro- and Antisocial Behavior Scale in Sports (ECPA-S, Kavussanu & Boardley, 2009), but there are few measures aimed at e-sports that focus on behavior itself, at both the individual and collective levels.

Although there are measures or tools of behavioral analysis for the sports context, there is a need to expand the behavioral concepts measured by devising and validating instruments specifically for e-sports players, the demand for research on which is constantly growing. A scale of this nature may enable us to analyze behavioral aspects in the context of e-sports in a way that is more on the demands and characteristics of this sport that involve different types of team games (e.g., League of Legends and Counter Strike: GO), linked to actions, thoughts, and strategies that can occur during a competition. Another aim is to facilitate the performance of empirical studies that would link the behavior of these players to various psychological (e.g., mental health and well-being) and physical dimensions (e.g., level of performance and motor skills), expanding the scientific knowledge base and fostering the creation of techniques aimed at dealing with this particular group.

This study aims to develop and validate an instrument to assess behavior in electronic gaming in a Brazilian sample. Specifically, indicators of factor validity and internal consistency of the Electronic Game Behavior Scale are presented.

Study 1. Elaboration of the Game Behavior Scale–Electronic (GBS-E)

Study 1 aims to describe the construction of the Game Behavior Scale–Electronic, proposing evidence of factorial validity and internal consistency of the measure.

Methods

Participants

A total of 409 Brazilian electronic gamers participated in the present study. Their mean age was 21 years (ranging from 18 to 34 years; $SD=3.07$). Most were male (68%), single (85%), and were students who did not work (54.3%), and a plurality declared themselves to be middle-class (47%). This was a convenience sample (nonprobabilistic), as it included those who, when requested, were willing to participate in the study.

Instruments

Initially, 50 items were included in GBS-E), a self-report instrument developed based on the responses of 20 e-sports players (semistructured interview; e.g., "What do you do during the match?" "In what position do you play?" "What is your goal during the match?"), as well as on the definitions of e-sports identified in the literature (Goedert & Soares, 2019) and on the theoretical models of individualism-collectivism (Hofstede, 1980; Triandis, 1994).

Next, content validity analysis was applied to the initial version by five judges (professors/doctors in the areas of social psychology and psychometry), who completed a form that evaluated the semantic and conceptual relevance of the items as representations of the latent trait under study. At least 80% agreement between the judges was required for inclusion of an item. After analyzing the responses, five items were excluded, culminating in the 45-item version that was made available to five participants of the target sample (players), who indicated that they adequately understood the semantics of the items and their response scale (5-point Likert scale, ranging from 1 – does not fully describe me to 5 – fully describes me). Sociodemographic questions (sex, age, socioeconomic status, and marital status) were also added.

Procedure

Data were collected virtually through an online platform through the dissemination of the survey link on social networks (e.g., Facebook and Instagram). On the home page, the informed consent form was presented, agreement with which was required for continued participation. The confidentiality and confidentiality of the data collected were ensured, in addition to informing participants about their freedom to quit the study without any consequence. The inclusion criteria of the study were to be a Brazilian of legal age who plays electronic games. On average, it took five minutes to complete the study. The study was approved by the Research Ethics Committee (CAAE: 79981517.5.0000.0021) and followed all ethical principles of Resolutions Resolution 466/2012 and 514/2016 of the National Health Council.

Data Analysis

Exploratory factor analysis: The dimensionality of the scale was analyzed by means of exploratory factor analysis, minimum rank factor analysis (Shapiro & ten Berge, 2002), oblique rotation *Promin* (Lorenzo-Seva, 1999)) and the Hull Comparative Fit Index (CFI) (Lorenzo-Seva et al., 2011), which aims to identify which factorial structure best fits the observed data and their respective degrees of freedom from polychoric correlation matrices (Holgado-Tello et al., 2010)). The analyses were performed using Factor 10.10.3 software (Lorenzo-Seva & Ferrando, 2006).

Reliability: McDonald's ω was calculated with SPSS plugin version 21 (Hayes & Coutts 2020).

Results

The Kaiser–Meyer–Olkin test (KMO=0.80) and Bartlett's sphericity test [$\chi^2(435)=1579.40$, $p<0.001$] demonstrated the adequacy of the polychoric correlation matrix for performing exploratory factor analysis. Through the Hull CFI criterion (CFI=0.98, $df=376$), we identified a structure consisting of two factors. The two factors together explained 41% of the total variance.

Saturation ≥30 was used as the criterion to define the belonging of an item to a factor, and the items with values lower than this in two factors were eliminated. Thus, items 3, 6, 9, 11, 31, 34, 36, 39, 40, and 44 had factor loadings above 0.30 in both factors, while items 4, 26, and 33 did not reach a factorial load to be included in any factor, so they were excluded from further analysis. Given these results, the GBS-E showed a bifactorial structure with 31 items.

According to Table 1, the first factor included 17 items with factor loadings ranging from -0.35 (Item 17, *"I usually do poorly situations where I need to be impulsive"*; item reversed) to 0.62 (Item 37 *"When I have the advantage, I can intimidate my opponents"*). This factor was named "Individual Behavior", presenting an indicator of satisfactory reliability (McDonald's ω=0.79) (>0.70) and a mean score of 3.80 ($SD=0.51$). The second factor included 14 items with factor loadings ranging from -0.35 (Item 19 *"To act in a group, I need a good reward"*; item inverted) to 0.78 (Item 45, *"I feel fulfilled when I can provide security to my team"*). It was called "Collective Behavior", and it had a satisfactory reliability index (McDonald's ω=0.78) and a mean score of 4.11 ($SD=0.49$).

Table 1
Factorial structure of the Game Behavior Scale–Electronic (GBS-E)

Items	F1	F2
01. In the game, it is essential that I put the needs of the team ahead of my own.	-0.16	**0.51**
02. I can do well with unforeseen events.	**0.50**	0.02
03. When I am in a match, I depend on others to stand out.	-0.49	0.35
04. My team relies on me to remain calm in moments of decision.	0.14	0.28
05. When I am in a game, I need to act fast to have the advantage.	**0.47**	0.12
06. Being independent is important to me.	0.57	-0.36
07. For me, victory is defined by the success of the team.	-0.03	**0.62**
08. I like to help achieve goals.	-0.10	**0.66**
09. I tend to depend on others to act.	-0.57	0.36
10. Knowing how to act together is one of my qualities.	0.11	**0.58**
11. I don't need others to do my best.	0.46	-0.32
12. I feel confident when I know I have the advantage.	**0.56**	0.01
13. I can easily redirect my focus.	**0.44**	0.09
14. I like being responsible for a good move.	**0.41**	0.23
15. When I act, I think about what is best for the team.	0.06	**0.62**
16. When I am in a match, I can easily analyze the situation of my team.	**0.54**	0.06
17. Generally, I don't do well in situations where I need to be impulsive.*	**-0.35**	0.18
18. I have the ability to develop new strategies.	**0.62**	-0.07
19. To act in a group, I need a good reward.*	0.11	**-0.35**
20. I don't need help to get what I want.	0.41	-0.52
21. I feel good when the team is doing well.	0.07	**0.64**
22. My positioning choices can change the direction of a competition.	**0.48**	0.29
23. I know how to explore the enemy's weaknesses.	**0.62**	-0.01
24. I can do well by doing several things at the same time.	**0.50**	0.11
25. I feel good when I have control.	**0.57**	0.13
26. Not always do my goals coincide with those of my team.	0.24	-0.21
27. I need to trust others to do my job.	-0.23	**0.46**
28. For me, it is important to seek advantages in a match.	**0.55**	0.22
29. I like others to follow my plans.	**0.48**	-0.04
30. I am present when my team needs me.	0.06	**0.48**
31. I get the best result when I am focused.	0.36	0.33
32. For me, it is important to provide well-being to others.	-0.17	**0.70**
33. I do not expose myself to risky situations.	-0.09	0.18
34. I don't need help to get what I want.	0.48	-0.55
35. For me, it is important to be in the right place at the right time.	0.26	**0.42**
36. Generally, people feel comfortable in my presence.	0.31	0.43
37. When I have the advantage, I can intimidate my opponents.	**0.62**	0.05
38. I feel confident when I know I am supported by allies.	0.08	**0.61**
39. I do my best when I am focused on a goal.	0.33	0.47
40. I like people to trust me.	0.35	0.51
41. I don't usually have difficulty with individual tasks.	**0.53**	-0.15
42. I like to think about several things at the same time.	**0.45**	0.13
43. When I am in a match, I know I cannot act alone.	-0.26	**0.62**
44. I feel good when I have control of my things.	0.50	0.36
45. I feel fulfilled when I can provide security to my team	0.12	**0.78**
Number of items	17	14
Eigenvalues	8.34	5.98
Variance explained	24%	17%
McDonald's ω	0.79	0.78

Note. Inverted items

Study 2. Proof of structure and proposal of GBS-E and its short version

Study 2 aimed to perform confirmatory analyses and propose a short form of GBS-E.

Methods

Participants

A total of 373 Brazilian electronic gamers participated in the present study. They had a mean age of 21 years (ranging from 18 to 32 years; $SD=2.97$). Most were male (73%), single (88%), only studied and did not work (55%), and declared themselves to be middle class (52%). As in Study 1, this was a convenience sample (nonprobabilistic) of those who, when they received the link to the form, agreed to voluntarily participate.

Instruments and procedure

The same ethical procedures, sample inclusion criteria, and data collection methods as in Study 1 were used. The participants filled out GBS-E (31-item version of Study 1) and demographic questions (e.g., sex, age, and marital status). On average, 5 minutes was enough to complete participation.

Data analysis

Confirmatory factor analysis: The lavaan package (Rosseel, 2012) was used with the weighted least squares mean- and variance-adjusted (WLSMV; Muthén et al., 1997), considering the CFI and Tucker–Lewis Index (TLI) indicators. These were deemed adequate when greater than 0.90 or close to 0.95. The root mean square error approximation (RMSEA) and its 90% confidence interval (90% CI) was deemed adequate when ≤ 0.06 or when <0.10 for small samples or samples with low degrees of freedom. The figures were drawn with the aid of the semPlot package for R (Epskamp & Stuber, 2017)).

Analysis of the items: The parameters of the items evaluated according to item response theory (Chalmers, 2012) were as follows: (a) discrimination - whose interpretation of the results uses the guidelines proposed by Baker (2001), according to which the items can be classified as (1) nondiscriminative =0, slightly discriminative =0.01 to 0.34, somewhat discriminative =0.35 to 0.64, moderately discriminative =0.65 to 1.34, very discriminative =1.35 to 1.69, and extremely discriminative ≥1.70; and (b) difficulty (thresholds) – consists of the indication of the level of a latent characteristic that is necessary for the respondent to endorse each point of the scale of response analyzed through intervals ranging from $-\infty$ to $+\infty$ (Baker, 2001). These analyses were performed using the statistical software R (R Development Core Team 2016) with the *mirt* package (Chalmers 2012).

Analysis for building GBS-E short form: This was an exploratory graphical analysis to evaluate the fit of the dimensional structure to the data using the EGA package of R (Golino, 2017).

Results

Initially, a confirmatory factor analysis was performed with the version of GBS-E resulting from Study 1, which corroborated the bifactorial exploratory structure identified [$\chi^2(77)=229.5$; $p<0.001$; CFI=0.97; TLI=0.96; RMSEA=0.098 (90% CI=0.083-0.112)]. Then, the discrimination of each item of GBS was evaluated. As shown in Table 2, the discrimination parameters (a) were between -0.56 (Item 17) and 1.76 (Item 37) in Factor 1 (individual behavior) and between -0.69 (Item 19) and 2, 26 (Item 45). Thus, it was found that most items had moderate to high discrimination of the two factors of the measure. Items 17 and 19 showed unsatisfactory discrimination parameters (Items 17 and 19 = nondiscriminatory).

Regarding the analysis of the difficulty parameter (b), the latent trait levels necessary to endorse the items of GBS-E were low in both measurement factors, the participants having more difficulty selecting the upper options of the response scale than the lower options. Thus, the latent characteristic required to endorse the items was different for each factor (individual and collective), the dimension individual behavior showing an overall mean of -3.65 ($SD=2.28$) for the b_1 threshold and 0.38 ($SD=1.30$) for the b_4 threshold, while the collective behavior dimension had an overall mean of -4.20 ($SD=0.88$) for the b_1 threshold and 0.36 ($SD=0.92$) for the $b4$ threshold. In general, these results indicate that the items of both factors were efficient at evaluating the latent trait from -4 to 0. These results are listed in detail in Table 2.

The information curve of the scale visually shows the latent characteristic interval in which the factors were more accurate, summarizing the information functions that all items presented a continuum of latent characteristics. The results considering the two measurement factors are shown in Figure 1.

Based on the above findings, the adequacy of a short version of GBS-E composed of the five most discriminating items of each factor was examined, yielding a version with 10 items. At the exploratory level (EGA package), the items were analyzed based on network analysis, which consists of the graphical representation of a system of variables followed by the detection of groups of these variables to estimate the number of dimensions in psychological data. EGA has the additional benefit of not only estimating the number of dimensions but also determining which items belong to each dimension (Golino & Epskamp, 2017; Machado et al., 2015)). This resulted in the representation of the two factors shown in Figure 2.

Table 2
Parameters of the item response theory for the GBS-E items

Items	a	b_1	b_2	b_3	b_4	Items	a	b_1	b_2	b_3	b_4
Factor 1. Individual behavior						Factor 2. Collective behavior					
GBS37	1.76	-2.64	-1.73	-0.98	0.15	GBS45	2.26	-2.84	-2.30	-1.56	-0.54
GBS23	1.56	-3.10	-1.66	-0.30	1.06	GBS8	1.95	-4.44	-2.90	-2.57	-0.80
GBS13	1.43	-3.10	-1.66	-0.32	1.02	GBS21	1.62	-4.21	-3.83	-2.78	-0.88
GBS16	1.30	-2.73	-1.12	0.11	1.41	GBS15	1.42	-4.19	-2.51	-0.73	0.76
GBS18	1.29	-2.85	-1.39	0.15	1.72	GBS32	1.38	-2.96	-1.77	-0.62	0.49
GBS2	1.27	-3.29	-1.72	0.08	1.94	GBS38	1.36	-3.85	-2.87	-1.89	-0.38
GBS24	1.20	-4.15	-2.05	-0.28	0.98	GBS10	1.30	-4.41	-2.73	-0.97	0.80
GBS28	1.12	-4.32	-3.77	-2.31	-0.22	GBS7	1.09	-3.68	-3.21	-1.89	-0.41
GBS41	1.11	-3.07	-1.72	-0.32	1.16	GBS30	1.05	-5.58	-2.91	-0.63	1.39
GBS22	1.07	-5.01	-4.18	-2.56	-0.83	GBS43	1.03	-4.36	-2.62	-1.14	0.51
GBS25	1.01	-5.60	-3.95	-2.24	-0.18	GBS1	0.93	-5.10	-3.27	-0.74	1.72
GBS12	0.87	-5.11	-3.77	-2.58	-0.50	GBS35	0.86	-5.66	-4.28	-2.06	0.22
GBS42	0.84	-3.40	-1.82	-0.17	1.21	GBS27	0.80	-3.39	-1.88	-0.24	1.75
GBS5	0.84	-4.27	-2.66	-1.16	0.57	GBS19	-0.69	0.57	-1.99	-3.35	-4.94
GBS29	0.83	-4.84	-2.52	-0.51	1.06						
GBS14	0.77	-8.03	-4.20	-2.66	-0.56						
GBS17	-0.56	3.41	1.04	-1.13	-3.48						

Note. a=discrimination; b_{1-4}=*threshold*

Figure 1
Information curve of each factor

Fator 1. Comportamento Individual

Fator 2. Comportamento Coletivo
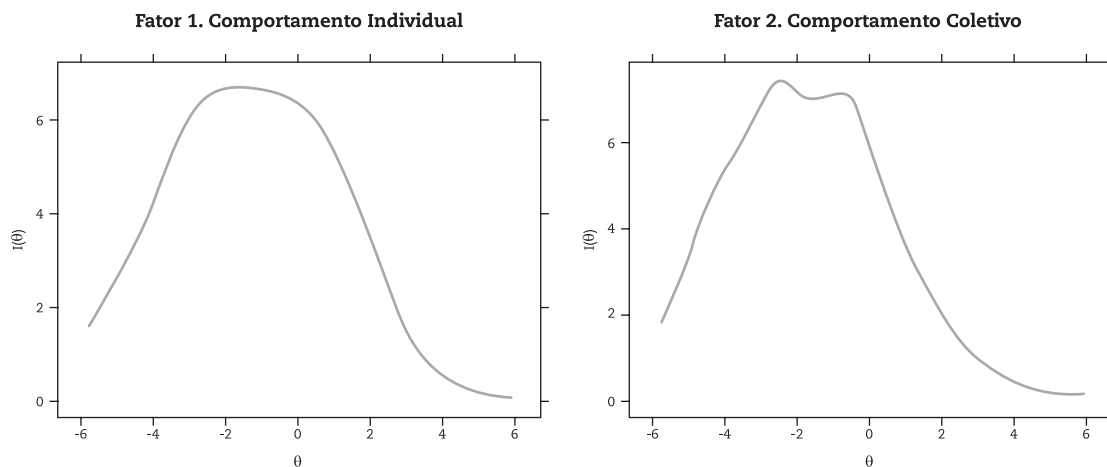
In addition, it showed adequate internal consistency (McDonald's ω) of 0.83 in the individual behavior factor and 0.82 in the collective behavior factor. This two-factor solution was also corroborated by other criteria, such as Cattell (scatter diagram), Horn (parallel analysis), and bootstrapping (resampling) (Figure 3).

Finally, the structure of the short form was analyzed by means of confirmatory factor analysis, and the findings supported the structure with two factors [$\chi^2(34)=143.4$; $p<0.001$; CFI=0.92; TLI=0.90; RMSEA=0.064 (90% CI=0.054-0.075)], corroborated in the latent traits model figure (Figure 3).

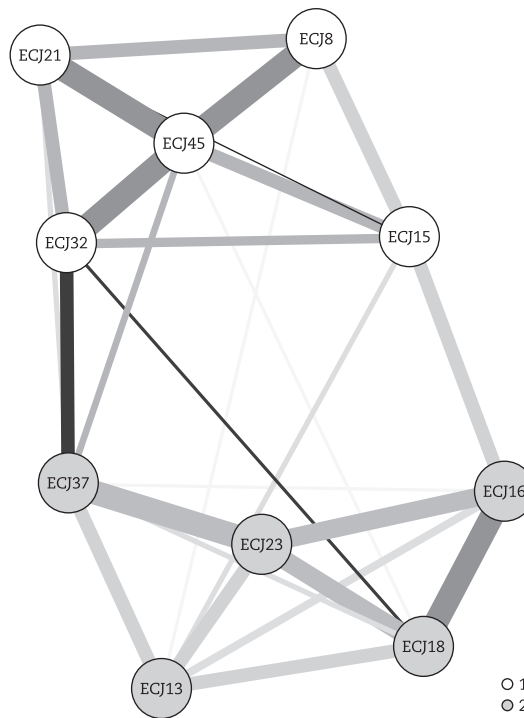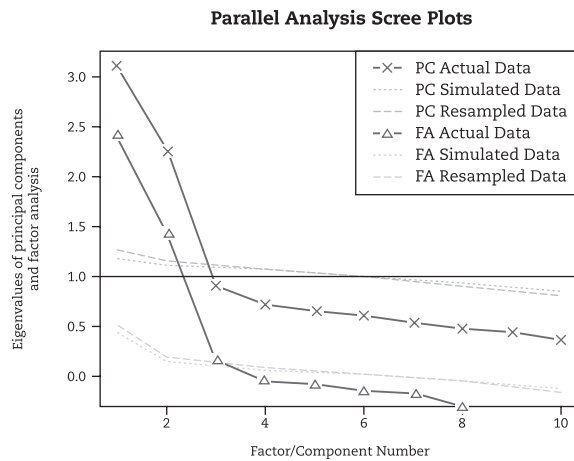**Figure 2**
Exploratory graphical analysis

Figure 3
Indicators of the number of measurement factors

Parallel Analysis Scree Plots

Discussion

Study 1 and Study 2 had the general objective of gathering evidence of psychometric adequacy for the GBS-E elaborated in this study, evaluating its validity (factorial) and internal consistency (McDonald's ω) in a Brazilian sample. We believe that we achieved our purpose, providing evidence of psychometric adequacy about a measure that can be adequately used in the Brazilian context to evaluate the in-game behaviors of electronic gamers in future studies. The main results are discussed below.

In Study 1, we gathered psychometric evidence for GBS-E through exploratory factor analysis, using polychoric correlation matrix, minimum rank factor analysis, the Hull factor retention criterion, and promin rotation (by seeking not to delimit, a priori, the interaction between the factors and to identify simpler factors; Lorenzo-Seva, 1999), identifying a two-factor structure consisting of 31 items in total that presented satisfactory factor loadings (>0.35; Pasquali, 1998).

In the individual behavior factor, items were included that showed behaviors of a more individualistic nature (e.g., Item 24, *"I can do well by doing several things at the same time"*), that reflected emotional detachment from one's opponent to develop winning strategies (e.g., 23, *"I know how to explore the enemy's weakness"*), and that had to do with ease in achieving one's goal without the team (e.g., 41, *"I do not usually have difficulty with individual tasks"*). In the collective behavior factor, items referring to behaviors of a more collective nature centered on the good of the team (e.g., 1, *"In the game, it is essential that I put the needs of the team ahead of my own"*), prioritizing interpersonal relationships with the team to achieving the game's goals (e.g., 10, *"Knowing how to act together is one of my qualities"*), and focusing on providing a game environment that favors the whole team (e.g., 15, *"When acting, I think about what is best for the team"*). These behaviors are similar to the profiles of athletes advocated by Melo and Giavoni (2010) in a study starting from theoretical models of individualism–collectivism (Hofstede, 1980; Triandis, 1994).

In Study 2, the confirmatory factor analysis of the bifactorial structure provided information on the fit of the model that suggests its adequacy, with indicators exceeding the cutoff points recommended in the literature (e.g., CFI and TLI>0.90 and RMSEA<0,10; Tabachnick & Fidell, 2013). In addition, the items were evaluated for the discrimination and difficulty parameters based on item response theory (Chalmers, 2012), whose findings indicated moderate and high discrimination in both measurement factors (except in two items – one of each factors, as it is not discriminative) and levels of difficulty that portray the efficiency of the items in the evaluation of the latent trait under study (Baker, 2001), that is, of the individual and collective behaviors shown in the game.

Based on the item discrimination indicators, a short form of the instrument was developed, which was corroborated both at the exploratory level by means of graphical exploratory analysis (EGA; Golino, 2017; Golino & Epskamp, 2017), which identified and corroborated the bifactorial structure, and at the confirmatory level (CFI>0.90, TLI>0.90, and RMSEA<0.08; Tabachnick & Fidell, 2013), which endorses the viability and suitability of the short form with 10 items equally distributed in the two factors and corroborated by multiple criteria (e.g., Cattell, Horn, and bootstrapping).

Regarding the internal consistency of the measurement (McDonald's ω), GBS-E had indicators that support its evidence, and in both Study 1 and Study 2, indices higher than the cutoff point commonly recommended in the literature were found (0.70; Hayes & Coutts 2020), both in the long version (17 items – Study 1) and in the short version (10 items – Study 2). Thus, the factorial structure of GBS-E was analyzed and corroborated by two independent studies, one of an exploratory nature and the other with more confirmatory methods, so this instrument seems viable because it has evidence of factorial validity and internal consistency.

Despite the aforementioned comments highlighting favorable findings that recommend the use of this measure in the context of the Brazilian reality, the studies described here are not without limitations. First, sample bias (nonprobabilistic) is emphasized, as the sample does not reflect the actual composition of the target population, and the sample size was small, preventing its generalization to the entire Brazilian audience of electronic gamers. However, it should be noted that the ultimate purpose was not exactly to study the behaviors of the players themselves but to develop and validate a measure that will allow these to be evaluated in the future. Thus, the number and nature of the participants can be considered sufficient for the psychometric purposes outlined in this study (Pasquali, 1998).

Another important aspect to highlight is social desirability bias, which leads subjects to respond to reveal their most favorable or socially accepted traits. This problem is common in studies that address sensitive subjects, and in regard to electronic sports, it is known that common sense and the scientific community tend to highlight the negative points of its practice, and this element might have impacted the participants' responses. This is not an exclusive difficulty of this measure, and we encourage the future use of alternative strategies, such as the use of social desirability measures that allow controlling this bias (Soares, et al., 2016).

Finally, despite the possibility of applying GBS-E in future studies, our findings should be replicated in broader and more diverse samples that include players of different age groups and that differentiate between amateurs and professionals. In addition, complementary evidence of validity (e.g., convergent, discriminant) and the temporal stability of the measure (e.g., test–retest precision) can be gathered in the future. Studies could also aim to identify potential antecedents and consequences of behaviors in the game because this behavioral pattern can be empirically related to several constructs evaluated in the context of sports, such as psychological indicators (e.g., anxiety, stress, positive affects) and performance (e.g., high and low yield), favoring the expansion of knowledge about the broadly expanding area of e-sports.

In summary, evidence of the psychometric adequacy of GBS-E was collected. This is an instrument

that can be used appropriately in future studies that are interested in measuring dimensions of individual and collective behavior in the Brazilian context, as well as in different fields of study (e.g., psychology, physical education).

Authors' contributions

We declare that all authors participated in the preparation of the manuscript. Specifically, the authors Ana Karla Silva Soares and Maria Celina Ferreira Goedert participated in the initial writing of the study (conceptualization, investigation and visualization); the author Tailson Evangelista Mariano participated in the data analysis; and the authors Ana Karla Silva Soares and Maria Celina Ferreira Goedert participated in the final writing of the paper (review and editing).

Availability of data and materials

All data and syntax generated and analyzed during this research will be treated with complete confidentiality due to the Ethics Committee for Research in Human Beings requirements. However, the dataset and syntax that support the conclusions of this article are available upon reasonable request to the principal author of the study.

Competing interests

The authors declare that there are no conflicts of interest.

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Sobre os autores

Ana Karla Silva Soares is a psychologist (UFPB), PhD in Psychology from the Federal University of Paraíba (UFPB). Currently, she is a Professor of Psychology at the Federal University of Mato Grosso do Sul, Campo Grande Campus (MS).

Maria Celina Ferreira Goedert is a psychologist (UFMS) with a master's degree in Psychology from the Federal University of Mato Grosso do Sul (Universidade Federal do Mato Grosso do Sul – UFMS), Campus Campo Grande (MS).

Tailson Evangelista Mariano is a psychologist (UFPI), PhD in Psychology from the Federal University of Paraíba (UFPB). Professor of Psychology at the Catholic University of Pernambuco, Recife (PE).

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