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AN ANALOG GAME-BASED INTERVENTION AND A PLAYABILITY ANALYSIS IN THE ELDERLY–A PILOT STUDY

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Abstract

Introduction: Gamed-based interventions (GBI) in old people is an interesting topic for aging-well purposes, however, few studies exist focused on the assessment of multimodal interactive experience (emotions, skills, engagement, etc), and most of them used digital games. Therefore, validation of analog GBIs, when implemented in the geriatric field, should be completed with a playability analysis.

Aim: To characterise a multicomponent playability analysis, considering (i) emotional state changes, and (ii) the perceived experience during the implementation of an analog gamed-based short-term intervention in the institutionalized elderly person

Method: A pre and post-test study was conducted during four weeks of intervention through an analogue game. Participants were elderly people institutionalised in a Residential Home for the Elderly in the central region of Portugal. Playability is assessed before and after the sessions with analogue games, using the Visual Analogue Scale (VAS) (0-10) of emotions and a questionnaire about participants' perceptions of game-based experience.

Results: Thirteen elderly people (9 women/4 men) with a mean age of 80±9.32 years participated in the study. A total of 48 states of tiredness/ excitement, calmness/anxiety, and sadness/joy were recorded: 44,4% of participants increased their level of excitement; 66,7% decreased their level of excitement. The serious aims of the game were well perceived while maintaining the perception of the playful and fun character.

Conclusion: The positive emotional changes in the elderly might be a sign of self-perceived novelty and challenge in the game. A good perception of the serious purpose of the game is associated with a positive emotional state, which encourages the adoption of proficiency feedback mode in the game. This pilot study was a relevant contribution to the continuing progression of playability analysis in elderly therapeutic contexts.

Keywords: Aging; Recreation Therapy; Recreational Games.

Introduction

With the increase in the number of older people, issues related to aging will be highly relevant, as well as the political, health, and even conceptual challenges of managing frailty in older people (Adja et al., 2020; Kojima et al., 2019). Taking into account, older people and their families often choose to request support in long-term care institutions, which ensure the satisfaction of their fundamental needs, well-being, and the perception of good emotions, such as happiness and motivation life (Chruściel & Dobrowolska, 2020; Ghenţa et al., 2022; Schweighart et al., 2022).

Institutionalization is marked by a change in interpersonal relationships in the daily routine, which become pre-established and not very flexible for daily activities (e.g., eating, sleeping, or bathing) (Bruinsma et al., 2021). These changes in routine can trigger a sedentary and passive lifestyle, fostering a reduction in occupational activities (Ramalho & Petrica, 2023). According to a narrative review by Charles and Carstensen (2010), the changes in activity involvement in older people have particular relevance in functionality and therefore it is a crucial aspect for guaranteeing a healthy and happy aging for institutionalized old people.

Activity involvement is a complex domain, that could be characterized in terms of different domains. For example, understanding emotions is crucial for older people, given their evolutionary significance and contributions to health and well-being (Kechen et al., 2023; Saad & Mansori, 2017). Emotions play a central role in every human life from the moment we are born until we die, considering its importance for the body for action and guiding decisions and actions (Ebner & Fischer, 2014). In fact, negative emotions, such as anger, depression, and anxiety predict more significant disease morbidity and mortality (Suls, 2017). In contrast, positive emotions impact older individuals' physical health (locomotion, fitness capacity, etc.) (Ong et al., 2011). Research shows that older people who experience positive emotions are less vulnerable to becoming frail, characterized by a decline in strength and physical performance, leading to a higher risk of disability (Åhlund et al., 2020; Gordo et al., 2021; Park-Lee et al., 2009).

Perceiving an event as a positive experience is also an important aspect of the satisfactory involvement of the elderly in an activity, however, few studies have been focused on collecting user's perspectives on innovative practices in gerontology (Lin et al., 2018). The few contributions to this topic have been testing robotics/technology methods, physical activity protocols, and psychotherapy methodologies. In this previous research, there is a consensus on the importance of measuring users' perspectives for increasing their willingness to continue to participate in activities, but also to promote their decision-making (Graham & Connelly, 2013; Lee et al., 2020; Šabanović & Chadwicke Jenkins, 2022).

An increment in activity involvement for old people is crucial for a positive adaptation in the institutionalization process and it may be a trigger for adapting or developing new intervention models. Game-based interventions (GBI), particularly the interventions using analog games, are a very recent and innovative model that can be implemented for aging well purposes (Jean François et al., 2013). Specifically, analog games have components for handling and interacting with the pieces, do not require digital literacy, and are versatile in their application

(Miltiades & Thatcher, 2019). In fact, there are special collections of games designed for therapy and stimulation purposes with cognitive and motricity benefits, already reported in previous studies (Gordo et al., 2021; Rosa et al., 2023).

The validation of GBI, when implemented in the geriatric field, should be completed with a playability analysis. According to Salazar-Cardona et al. (2023), the playability analysis should describe the interactive experience of human enjoyment when playing games. This analysis should provide subjective measures such as emotion and other self-perceived variables such as engagement, satisfaction etc. Different authors suggested different attributes for playability analysis. For example, the authors González-Sánchez et al. (2009) included learnability (knowledge, skills, difficulties) as something crucial for this analysis.

Most of the studies that have explored playability analysis were focused on digital games. A systematic literature review investigated the player experience of the elderly in digital games and concluded that there are not many specific studies on playability and player experience applied to older adults, nor are there consensual methodologies to evaluate them (Rienzo & Cubillos, 2020). Moreover, studies exploring playability analysis of analog games for old people are not known.

The present study intended to explore a multicomponent playability analysis, considering (i) emotional state changes, and (ii) the perceived experience during the implementation of an analog gamed-based short-term methodology in the institutionalized elderly person.

METHODS

A pre and post-test study was carried out, using a special designed analog GBI. The protocol was implemented in a Long Stay Institution in the central region of Portugal. The data was collected between May and June of 2023. The study was approved by the Ethics Committee of the Polytechnic Institute of Leiria (REF.ce-ipxxx-xx-20xx) and by the director of partner institution.

Sample

After an explanation of the aim of the study, a group of older adults was recruited from a Long Stay in the center region of Portugal, considering the following inclusion criteria: (i) older people (≥60 years old) who agreed to participate in the study; (ii) who successfully completed a battery of cognitive tests (the clocking drawing test with no mistakes in numbers distribution and mini mental state examination with score higher than the adjusted cut-off value) (Aprahamian et al., 2009; Santana et al., 2016); and (iii) with preservation of mobility of the upper limbs (at least horizontal reaching; potential to perform a gross grasp . Older People with a clinical diagnosis of dementia or severe visual perception (inability for recognizing figures distributed on the board game) problems were excluded. The procedures for guaranteeing anonymity, privacy, and confidentiality of data (personal information, such as the name or the address, were exclusively consulted by the principal researcher; other involved researchers had access to participants 'data in a confidential manner, using codification codes) and obtaining informed consent and willingness to participate in the study were ensured.

Procedures

The evaluation and implementation were carried out by one investigator (DP) specially trained to implement the protocol for the playability analysis. The first week was specific to implementing the initial assessment, and the four weeks after were focused on the implementation of GBI. In the last week, a re-evaluation was carried out.

To promote an experience enriched on feedback and social interaction during the GBI, teams of two senior players were chosen according to the functional and cognitive levels. The sessions lasted 25/30 minutes per day, twice a week.

Initial assessment

The initial assessment, which included the sociodemographic characterization and the level of cognition and functionality, was performed by a single researcher and physiotherapist, previously trained for the use of the assessment and intervention instruments, as well as for the implementation of the GBI.

Initially, 24 older adults were assessed, but 11 were later excluded because: they were not able to understand and answer the Visual Analogue Scale (VAS) for emotions (n=1); have dysfunction in the upper limb due to brachial plexus injury (n=1); leave the institution (n=1) and do not accept to participate (n=8).

Characteristics of the Analog Game

The game implemented was the Ta!Ti! Hand Game (from the Agilidades Inc. collection) (Figure 1), which is specific for training upper limb coordination and rhythm with multiple cognitive stimuli (figure 1). This game features 1 table board, 1 set of Single Game cards (to play with one hand); Double Game cards (to play simultaneously with two hands); 1 dice to plan the Single Game; cards to plan the Double Game; 1 Bell; 1 Glass Cup (Gordo et al., 2021).

The Ta!Ti! Hand Game board has 35 figures of familiar objects, disposed in 5 different lines. The board should be placed on the table, centered on the player's torso. Single game cards have clear instructions from which figure should the player touch, the cup's positioning on the right figure from the board, and the upper limb (in this basic level, the player only interact with a single upper limb) that should be used to manipulate the glass cup to the board. The dice was only used to address a new instruction in single game cards mode. In fact, the dice has 6 associated sounds to be implemented to the game, according to the glass position on the board (Gordo et al., 2021). When playing in a competition mode, the dice could instruct different combinations of sounds per player (Taaa; Tiii; Shiuu), which stimulates the selected attention in the game and also some musicality, rythm and fun to the context (Gordo et al., 2021).

Double game cards are representative of a more advanced level of Ta!Ti! Hand Game. In this mode, the player interacts with both upper limbs on the board, while they need to find two different figures. When the player used double game cards (having 2 figures), they also need to catch specific cards with the design of two glasses in a random position. These cards have written information of the sound they need to say, replacing the role of the dice in this player advanced level.

These two different levels of Ta!Ti! Hand Game need to be completed in the shortest time possible. The first player finishing a card, owns the maximum score of 10 points for the basic level or 20 points for the most complex/advanced level.

Game-based intervention

The Ta!Ti! Hand Game was implemented during 20–30 minutes in each session.

In the first session, at least ten minutes were use for introducing the components of the Ta!Ti! Hand Game, including: reading and interpreting the figures on the board; reading and interpreting the cards; reading and interpreting the dice. After that, the game instructions were explored between players and basic doubts were clarified. In particular, we introduced at least 3 cards of each gaming level.

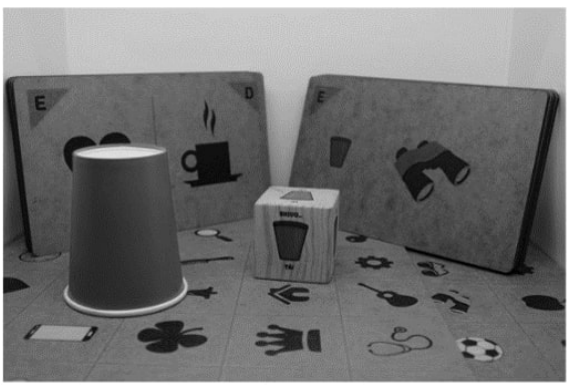

Figure 1
Components of the game Hands Ta!Ti!

In the first week of the experiment, the game was played in its basic level, proposing unilateral moves without using the dice, with the card showing the image to be sought, the position that the glass should be on the board, and the upper limb used to manipulate the glass cup. The progression to bilateral moves (gamed advanced level) was made as the participants showed good adaptation to the game.

Instruments for the Playability Analysis

Visual Analog Scale for emotional state assessment

To assess the Emotional State (before and after game-based procedures), the VAS for emotions was used (Figure 2). This method was proposed in the study carried out in 2019 by Theorell and Horwitz (Romanowska et al., 2016) and validated for the Portuguese language (Moura-Ramos et al., 2004). This scale is based on the concept of fundamental emotions, transversal to different cultures and essential to characterise the responses of individuals in the most different contexts (Theorell & Bojner Horwitz, 2019). The 10cm VAS was applied in the following dimensions: tiredness-excitement, sadness-joy, and anxiety-calm. The participants were instructed to score their state of tiredness and excitement (0 tired tend, ten etc.); anxiety and calm (0 anxious and ten calm); sadness and joy (0 sad and ten joy)16. Facial expressions were added at the extremes of the scale to facilitate the interpretation of the values (Theorell & Bojner Horwitz, 2019).

Questionnaire for the assessment of elderly's perception

A questionnaire was applied, to assess the elderly's perception on the experiences with the game. The questionnaire used was adapted from the study conducted by Rosa and colleagues (Rosa et al., 2021a). This instruments used Likert-type score (1-meaning very little, 5-meaning very much/often), on two different dimensions: (i) serious-purpose perception: the effect of the game on memory stimulation ("Have you worked on your memory?"); upper limb movement ("Do you think the game helped with arm movements?"); (ii) engagement: perception of boredom ("Did you get bored during the game?"); perception of fun ("Did you enjoy the game?"); and quality of time spent ("Do you think the game was a waste of time?").

STATISTICAL ANALYSIS

Figure 2:
VAS Scale for emotions

Descriptive statistical measures are used to analyze the data collected. The results present absolute values per participant and for the total sample (mean ± standard deviation). The absolute and mean values before (T0) and after the game (T1) for each of the four sessions were used to characterize the emotional states. The differences between T1 and T0 for each one of the sessions are also calculated.

The differences between moment T1 of week two and week one interprets the global analysis between weeks. For the statistical analysis of the data collected through the questionnaire on the experiences with the game, the scores of questions 2 and 5 were inverted, and mean response values were calculated per domain approached and per elderly. The Q1, Q2, Q3, Q4, and Q5 codes were attributed to questions 1, 2, 3,4, and 5, respectively.

Spearman's correlation test was used to calculate the correlation between elderly's perceptions of the game-based experience and their emotional states. The rank correlation coefficient assumes a value in the range [−1; 1]. Magnitude between 0.7 and 0.9 indicate variables which can be considered highly correlated. Correlation coefficients whose magnitude are between 0.5 and 0.7 indicate variables which can be considered moderately correlated (Sedgwick, 2014).

RESULTS

Socio-demographic and clinical characterisation of the sample

Thirteen elderly people (≈69% women), mean age of 80 ± 9.32 years, were included. Table 1 presents the individual sociodemographic data of the participants.

The Emotional state

Forty-eight states were recorded (24 at T0 and 24 at T1) of tiredness/excitement (table 2), anxiety/calm (table 3), and sadness/joy (table 4). Table 2 describes the levels of each feeling per participant, before and after the game, in week 1 (ss1 and ss2) and week 2 (ss3 and ss4). 2 participants (ID 1 and ID 13) had only one session, and the remaining participants had two sessions.

Comparing the number of tiredness/excitement states between T1 of week two and T1 of week 1, an equal proportion (44.44%) of participants with increased and decreased scores was found. Mean values decreased from -1.41 to -0.44 in anxiety/calm, representing that most participants (66.7%) noticed a perceived decrease in anxiety scores between T1 of week two and T1 of week one. For the feeling of sadness/joy, it was possible to observe that participants (44.4%) showed an increase, with mean values increasing from 0.08 to 0.44.

Table 1
Socio-demographic characterization of the elderly participants (n=13)

ID	Age	Sex	Schooling (years)
1	87	F	9
2	70	F	5
3	80	F	7
4	84	M	6
5	92	F	4
6	94	F	4
7	84	M	4
8	61	F	5
9	84	M	4
10	80	M	5
11	82	F	8
12	80	F	12
13	68	F	4
MEAN and SD	80.46 ± 9.32		5.62 ± 2.46

Legend: SD: standard deviation; ID: numerical coding of the participant;

Table 2.
Characterization of the levels of tiredness and excitement (week 1/week2) of the elderly participants.

	Week 1								Week 2								
ID	T0 (ss1)	T1 (ss1)	Diff.	Diff sign	T0 (ss2)	T1 (ss2)	Diff.	Diff sign	T0 (ss3)	T1 (ss3)	Diff.	Diff sign	T0 (ss4)	T1 (ss4)	Diff.	Diff sign	ΔT1
1					3	7	4	↑	8	8	0	=	8	7	-1	↓	=
2	6	4	-2	↓	10	10	0	=	5	7	2	↑	6	7	1	↑	↓
3	8	8	0	=	7	8	1	↑	8	8	0	=	7	6	-1	↓	↓
4	8	10	2	↑	10	7	-3	↓	8	7	-1	↓	5	8	3	↑	↑
5	4	5	1	↑	5	8	3	↑									
6	5	7	2	↑	6	7	1	↑	5	8	3	↑	5	6	1	↑	↓
7	5	10	5	↑	8	5	-3	↓	5	6	1	↑	5	8	3	↑	↑
8	3	8	5	↑	6	7	1	↑					4	8	4	↑	↑
9	10	0	-10	↓	10	10	0	=	1	3	2	↑	10	6	-4	↓	↓
10	10	10	0	=	6	5	-1	↓	5	6	1	↑	7	9	2	↑	↑
11	7	9	2	↑	7	5	-2	↓									
12	5	3	-2	↓													
13	7	7	0	=	5	5	0	=									
Mean SD	6.50 ±2.23	6.75± 3.16	0.25± 3.93		6.91 ±2.23	7.00 ±1.80	0.08 ±2.15		5.62 ±2.38	6.62 ±1.68	1.00 ±1.30		6.33 ±1.87	7.22 ±1.09	**0.88 ±2.52**		

Legend: ss: session, SD: standard deviation; ↑–increase in score ( ); ↓–decrease in score ( ); = unchanged score ( ); ΔT1 = T1 (ss4) – T1 (ss2)

Table 3
Characterization of the levels of anxiety and calm (week 1/week2) of the elderly participants

	Week 1								Week 2								ΔT1
ID	T0 (ss1)	T1 (ss1)	Diff.	Diff sign	T0 (ss2)	T1 (ss2)	Diff.	Diff sign	T0 (ss3)	T1 (ss3)	Diff.	Diff sign	T0 (ss4)	T1 (ss4)	Diff.	Diff sign	
1					6	7	1	↑	4	7	3	↑	9	8	-1	↓	↑
2	5	5	0	=	7	3	-4	↓	5	5	0	=	4	3	-1	↓	=
3	8	8	0	=	7	7	0	=	7	7	0	=	8	8	0	=	↑
4	8	5	-3	↓	8	10	2	↑	10	10	0	=	8	8	0	=	↓
5	6	6	0	=	5	3	-2	↓									
6	9	8	-1	↓	0	8	8	↑	7	8	1	↑	7	7	0	=	↓
7	8	8	0	=	9	5	-4	↓	8	8	0	=	8	8	0	=	↑
8	9	4	-5	↓	8	5	-3	↓					8	7	-1	↓	↑
9	10	10	0	=	10	1	-9	↓	10	7	-3	↓	10	10	0	=	↑
10	5	5	0	=	8	6	-2	↓	7	5	-2	↓	10	9	-1	↓	↑
11	8	9	1	↑	7	5	-2	↓									
12	5	4	-1	↓													
13	6	8	2	↑	8	6	-2	↓									
Mean SD	7.25 ±1.76	6.66 ±2.05	-0.58 ± 1.83		6.91 ±2.53	5.5 ±2.43	-1.41 ± 4.07		7.25 ±2.12	7.12 ±1.64	-0.12 ± 1.80		8 ±1.80	7.55 ±1.94	-0.44 ± 0.52		

Legend: ss: session, SD: standard deviation; ↑–increase in score ( ); ↓–decrease in score ( ); = unchanged score ( ); ΔT1 = T1 (ss4) – T1 (ss2)

Table 4
Characterization of the levels of sadness and joy (week 1/week2) of the elderly participants.

	Week 1								Week 2								ΔT1
ID	T0 (ss1)	T1 (ss1)	Diff.	Diff sign	T0 (ss2)	T1 (ss2)	Diff.	Diff sign	T0 (ss3)	T1 (ss3)	Diff.	Diff sign	T0 (ss4)	T1 (ss4)	Diff.	Diff sign	
1					9	9	0	=	4	8	4	↑	9	9	0	=	=
2	2	4	2	↑	5	5	0	=	5	5	0	=	3	4	1	↑	↓
3	8	8	0	=	7	7	0	=	8	7	-1	↓	8	8	0	=	↑
4	8	8	0	=	10	10	0	=	8	8	0	=	8	8	0	=	↓
5	8	5	-3	↓	6	2	-4	↓									
6	8	8	0	=	7	5	-2	↓	7	8	1	↑	8	8	0	=	↑
7	5	8	3	↑	8	8	0	=	6	7	1	↑	8	10	2	↑	↑
8	9	8	-1	↓	10	6	-4	↓					8	9	1	↑	↑
9	10	10	0	=	9	10	1	↑	5	10	5	↑	10	10	0	=	=
10	5	10	5	↑	5	10	5	↑	8	8	0	=	8	8	0	=	↓
11	7	9	2	↑	7	9	2	↑									
12	4	4	0	=													
13	8	8	0	=	5	8	3	↑									
Mean DP	6.83 ± 2.32	7.5 ± 2.06	0.66 ± 2.05		7.33 ± 1.87	7.41 ± 2.50	0.08 ± 2.60		6.37 ± 1.59	7.62 ± 1.40	1.25 ± 2.12		7.77 ± 1.92	8.22 ± 1.78	0.44 ± 0.72		

Legend: ss: session, SD: standard deviation; ↑–increase in score ( ); ↓–decrease in score ( ); = unchanged score ( ); ΔT1 = T1 (ss4) – T1 (ss2)

Perceptions of experiences with the game

Regarding the perception of the role of the game in memory training, the average score was 3.5 points: minimum=3 (n= 8; 61.53%); maximum= 5 (n= 2; 15.38%). As regards to the perception of boredom with the game, the inverted mean score was 4.6 points: minimum=3 (n= 3; 23.07%); maximum=5 (n=10; 76.9%). On the perception of enjoyment with the game, the mean score was 4.1 points: minimum= 2 points (n=1; 7.69%); maximum= 5 (n=6; 46.15%). On the perception of the role of the game in stimulating arm movement, the total mean score was 3.9 points: minimum=1 (n= 1; 7.69%); maximum= 5 (n=4; 30.76%). About the perception of wasting time with the game, the inverted average of answers was 4 points: minimum= 2 points (n=1; 7.69%); maximum=5 (n=6; 46.15%). Table 5 shows the participants' perception of the implemented game.

Table 5.
Participants' perceptions of the activity involving the Ta!Ti! Hands Game (n=13).

Questions	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8	ID9	ID10	ID11	ID12	ID13	Mean
Q1.	4	3	5	3	3	3	3	3	5	3	3	4	4	3.5
Q2.	5	5	4	5	5	5	5	5	3	5	5	3	5	4.6
Q3.	5	5	5	4	5	3	5	4	5	4	2	4	3	4.1
Q4.	4	4	5	5	4	4	3	4	5	4	1	5	3	3.9
Q5.	4	5	5	5	3	4	5	5	3	3	2	4	5	4.0
Mean	4.4	4.4	4.8	4.4	4	3.8	4.2	4.2	4.2	3.8	2.6	4	4	4.0

Table 6.
Values for Spearman Correlation Between Participants' Perceptions and Their Emotions

	Q1	Q2	Q3	Q4	Q5	DT1 Tiredness and excitement	DT1 Calm and anxiety	DT1 Sadness and joy
Q1	R= 1.000	R= 0.826**	R= 0.286	R= 0.468	R= -.029	R= -.688**	R= -.014	R= -.392
	a=	a=<.001	a=.344	a=.106	a=.926	a=.009	a=.963	a=.186
Q2	R= .826*	R= 1.000	R= 0.421	R= .554*	R= .165	R= -.692**	R= -.176	R= -.200
	a=<.001	a=	a=.152	a=.049	a=.591	a=.009	a=.565	a=.513
Q3	R= .286	R= .421	R= 1.000	R= .358	R= -.169	R= -.359	R= .324	R= .328
	a=.344	a=.152	a=	a=.229	a=.581	a=.229	a=.280	a=.273
Q4	R= .468	R= .554*	R= .358	R= 1.000	R= -.094	R= -.276	R= -.309	R= .033
	a=.106	a=.049	a=.229	a=	a=.760	a=.362	a=.304	a=.915
Q5	R= -.029	R= .165	R= -.169	R= -.094	R= 1.000	R= -.344	R= .027	R= -.337
	a=.926	a=.591	a=.581	a=.760	a=	a=.250	a=.931	a=-260
DT1 Tiredness and excitement	R= -.688**	R= -.692**	R= -.359	R= -.276	R= -.344	R= 1.000	R= .096	R= .068
	a=.009	a=.009	a=.229	a=.362	a=.250	a=	a=.756	a=.827
DT1 Calm and anxiety	R= -.014	R= -.176	R= .324	R= -.309	R= .027	R= .096	R= 1.000	R= .014
	a=.963	a=.565	a=.280	a=.304	a=.931	a=.756	a=	a=.963
DT1 Sadness and joy	R= -.392	R= -.200	R= .328	R= .033	R= -.337	R= .068	R= .014	R= 1.000
	a=.186	a=.513	a=.273	a=.915	a=.260	a=.827	a=.963	a=

Legend: ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed); a, alfa value.

Correlations Between Participants' Perceptions and Their Emotions

Given the results presented in table 6, it is possible to highlight that Q1 ("Have you worked on your memory?") has a strong positive correlation with Q2 (perception of boredom) ($R = 0.826$, $\alpha < 0.001$), indicating that participants with high perception on memory work tended to feel less boredom during the game; There is a significant negative correlation between Q1 and ΔT1 Tiredness and excitement ($R = -0.688$, $\alpha = 0.009$), indicating that participants with more perception on memory work are those with low values in modification of VAS score for tiredness and excitement (tiredness accommodation); Q2 (perception of boredom) shows a moderate positive correlation with Q4 (upper limb movement) ($R = 0.554$, $\alpha = 0.049$), indicating that participants who felt less bored during the game also believed that the game helped with arm movements. The strong negative correlation between Q2 e ΔT1 Tiredness and excitement ($R = -0.692$, $\alpha = 0.009$) suggests that participants who felt less bored during the game significantly changed emotions of Tiredness and excitement.

Discussion

The present study suggests an easy, user-friendly, and non-time expensive paper-and- pencil analysis of playability in the geriatric area. Using this methodology, this pilot experiment demonstrated a positive emotional adaptation and a positive perception of an analogue GBI by institutionalized old people.

The data on the emotion scale suggests that this intervention program based on serious analog games provides: (i) an increase in excitement (ID4, 8- 9,10; 44.4% of participants); (ii) a decrease in anxiety (ID 1, 3, 7-10; 66.7% of participants); and (iii) an increase in joy (ID3, 6, 7,8; 44.4% of participants), over the time of implementation.

Regarding the increase in excitement over the course of the sessions in 44.4% of participants, and according to the previous literature, the increment in levels of excitement may be related to the process of learning and training for a particular activity (Parra-Rizo & Sanchis-Soler, 2020; Soyuer & Şenol, 2011). The same authors confirm that less tiredness may be due to the familiarization of repeated activities. According to this idea, for these 44.4% of participants, the Hand Tati game provided enough novelty and challenge, but for the others new and adaptable challenges should be considered.

In terms of the emotional states of anxiety, the results show that changes in perception were more successful in week 1 (T1ss1 vs T1ss2), compared to week 2 (T1ss3± 1.64; T1ss4). Two participants (ID2 and ID5) showed higher levels of anxiety in week 1, which they subsequently controlled over the course of the intervention. This may be due to the fact that an analog GBI have the ability to foster positive management of emotions, such as anxiety, in the elderly (Abd-alrazaq et al., 2021). By analyzing these results, it is also perceptible that the chosen board game did not lead to a state of chronic and difficult-to-manage anxiety and can be interpreted as an experience that promoted the feeling of self-efficacy. This is in accordance with a previous study that used a giant exercise board game in nursing home residents. In this study, the authors reported relevant psychological outcomes related to self-efficacy, which is important to increase the players' intrinsic motivation (Buckinx et al., 2020). In future research, it will

be important to list the most determinant characteristics in board games or in the GBI protocols to promote a positive anxiety management by the old people.

The increase in joy perception for 44,4 of participants was a very promising result. Additionally, and in accordance with the evaluation of elderly's perceptions, participants indicated a moderate perception of serious purposes (memory mean score of 3.5 vs movement mean score of 3.9), they attributed extremely high scores to funny game's properties (boredom mean score =4.6) and they considered the concept of the game as a meaningful activity (mean score of 4 for the question about wasting time perception). These results are an extremely important contribute for this area, as according to a previous study on digital games implementation for serious purposes in aging, an older adult that misperceived what a serious game is and what it may improves, may not see the benefit beyond this experience (Brown, 2017). The fact that participants were able to attribute health related benefits (memory and upper limb movements) to the game-based experience with TaTi-Hand game, has been established as a crucial criterion for its effectiveness for health gains by Gerling et al. (2015). These authors concluded that this is a strong determinant for stimulating learning effect and transfer for the performance of daily activities. In a previous scoping review the authors have concluded that there are other important perceived aspects to collect during elderly's game-based experience, such as (a) level of socialization; (b) expressiveness; (c) adventure. Interestingly, this suggests that questionnaire for the assessment of patients' perception might explore these new domains in future research for being able to provide a more comprehensive analysis for game-based experience (Nawaz et al., 2016).

Results from the present study demonstrated that participants who perceived greater cognitive work (eg., memory) during GBI tended to feel less bored and demonstrated increased levels of excitement. Accordingly, those participants that perceived less boredom during GBI were those that consider a major role of GBI in the upper limb movement and were those that highly changed in the emotions of fatigue excitement. These results highlighted the positive relationship that can exist between the perception of the serious purposes of the game and the positive emotional involvement. A previous qualitative and intergenerational evaluation of what is serious in games for older adults, conducted by Khalili-Mahani et al. (2020), concluded that most of the participants believed that playing games was related with improvement in cognitive functions (e.g., memory and attention), but few perceived social or emotional benefits (34%-42%). Also, feelings of relaxation and the opportunity to perform physical exercise during GBI are stated as a justification to play games by old people. Therefore, the quantitative results from the present study corroborate this qualitative research, pointing a new direction for the design of assessment methodologies in this field.

Such a change suggests that the level of playability provided by serious gaming may be directly related to the participant's emotional state. In addition, the results may also suggest that the implementation of the serious analog game could be an essential source for providing greater therapeutic quality in the elderly population (e.g., an increase in the number of

sessions per week, an increase in session time, greater encouragement during the session and fewer dropouts).

The multicomponent playability analysis implemented in the present study demonstrated a few considerable relationships between the two major components considered (emotional state and players' perceptions), which encourages to explore possible consequent influences between them. For example, it might be crucial to explain the serious purposes of the game, which means to further explain the player's goal orientation, to ensure the elderly's positive emotional involvement. According to previous literature in this field there are two different types of goal orientation (i) performance orientation – players' competence was assessed by others; (ii) master orientation – players are concerned with improving their proficiency. In fact, the protocol implemented with the Hand TaTi game in the current study, there was a performance orientation as it is constantly emphasizing direct goals like time and points earned. Future protocols with the Hand TaTi game might explore a master orientation protocol, by creating achievements that acknowledge the effort players and not only the player's mistakes or the errors (Dormann & Frese, 1994; Winters & Latham, 1996). Additionally, the nature of measures used for the playability analysis in the present study were considered as subjective measures, which might be completed by physiological indicators in future research methods, as for example (i) the facial electromyography, (ii) cardiovascular measures, (iii) electroencephalography (Bellotti et al., 2013).

The present study gathered a set of limitations to be considered in the design of future studies in this area: (1) there was no closed and objective criterion for the choice of pairs in the game, a factor which may have contributed to changes in emotional states; (2) the intervention time was concise, and some dropouts occurred; (3) the sample was reduced, comprising a single profile of older people in the process of institutionalisation.

Conclusion

This pilot study was a relevant contribution for the generation of new hypotheses in the development of methods for playability analysis, specifically when analogue GBIs are implemented for serious purposes in old people. The present study demonstrated that a GBI (in that case, using the Hand TaTi game) can induce positive emotional changes in the elderly, which might be a consequence of self-perceived novelty and challenge in the game. Furthermore, the old people that participated in this study perceived the GBI's serious purpose, without losing the perspective of having fun in the game experience. The correlation between the players' perception of serious purposes and the positive emotional adaption might suggest a modification to the protocol of the Hand TaTi game, specially dedicated to proficiency feedback.

The quantitative methodology suggested in this study is a relevant complement to qualitative methodologies published on this topic. Future studies, with more robust methodologies (highlighting perceived social and emotional benefits; the assessment of expressiveness or adventure game-based experiences; the assessment of physiological indicators), should be conducted.

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