Cultural viewpoint metaphors guiding the collaborative strategies design of a multitouch tabletop game for people with autism

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Abstract. Collaborative multitouch applications have been designed to support social interaction and collaboration skills in people with mild autism. However, this kind of application generally is not designed specifically for people with severe autism. We have proposed a set of collaborative strategies to manipulate the elements in the interface aiming to encourage the collaboration among users with severe autism. We applied this set of strategies in a collaborative multitouch game, named PAR. An empirical study with a group of users with autism using PAR, showed us the need to improve these collaborative strategies to provide a progressive learning of collaborative mechanisms. We conducted, therefore, the present qualitative study to inspect the intercultural experience promoted by PAR game in light of Cultural Viewpoint Metaphors (CVM), a conceptual tool of Semiotic Engineering theory. In this paper, we present the evaluation (by inspection) of the current intercultural situation of PAR, the identification of new features, and finally the redefinition of collaboration patterns with collaborative intercultural features intended for users with severe autism.

Keywords: Autism, Human-Computer Interaction, collaborative games, intercultural aspects

Introduction

Autism Spectrum Disorder (ASD) is a group of disorders characterized by deficits in different areas, mainly in the communication, language and social interaction, with presence of stereotyped behaviors (APA, 2000; WHO, 199). The severity of ASD varies according to the degree of impairment of the affected areas. People with mild autism have less difficulty to interact, their perception of the language is relatively normal, and they don't exhibit characteristics of intellectual disabilities (APA, 2000; Suplino, 2005). This type of autism is known as High-Functioning Autism [HFA] or Asperger's syndrome, considered mild within the autism spectrum (Wing, 1988).

People with more severe autism, in turn, may exhibit high impairment in some or many areas; total absence of language; higher indifference in social interaction, with preference to remain isolated; and even present some form of intellectual disability (APA, 2000). In this work, we use the term "Autism" referring only to these people with more severe impairments, and HFA referring to those with milder impairments.

The difficulty in social interaction is one of the most significant problems in people with Autism. They have problems to understand what another person might be thinking or

feeling. It also affects how they make sense of the world around them (APA, 2000; WHO, 199).

Different collaborative multitouch applications have been developed to mitigate, in some way, the difficulties of people with HFA (Batocchi et al., 2009; Bauminger et al., 2007; Chein, 2012; Giusti et al., 2011; Piper et al., 2006; Tse et al., 2007). Empirical studies with these collaborative applications have presented satisfactory results both in teaching and learning social skills and collaboration among users with HFA. However, it's not possible to conclude that we could reach the good results with users with Autism, due to their difficulty to understand and use certain strategies.

This work is part of a larger research, which aims at identifying the main characteristics for developing effective collaborative strategies to encourage collaborative and social interaction skills among people with Autism. In the first step of this research, we designed a set of collaborative strategies used in the collaborative multitouch game PAR (Acronym in Portuguese for Ask, Help, Receive), following specific requirements of a group of users with Autism. In the empirical evaluation of PAR game with this group of users, we obtained satisfactory results, particularly in the user interest in game and in the generation of social interaction expressions (Silva et al., 2014). However, we observed that users have some difficulties to easily understand the collaborative activities. Then, we decided to improve these collaborative strategies to gradually approximate the users to collaborative activities in the game, because this is a high impairment area for people with Autism.

This work is the second step of this research. Our goal is to redefine the collaborative strategies used in PAR game, including characteristics that allow the gradual approximation of the users to the culture of collaboration, facilitating step by step the appropriation of this "foreign" culture for them. We adopted a conceptual tool, Cultural Viewpoint Metaphors (CVM) to redefine the collaborative strategies (Salgado et al., 2012). CVM are a Semiotic Engineering (SE) tool (de Souza, 2005) to support the decision process about cross-cultural experience dimensions in the design process of Human-Computer Interaction (HCI). The CVM inherit, thus, the SE perspective, which sees HCI as a special case of computer-mediated communication, where, through the interface, designers say to users how, when, why, and what for, the system can be used. The interpretation of that message influences both the type of experience of HCI that the system promotes and whether the technology will have success.

CVM allow the elaboration and evaluation of intercultural approaches that happen in HCI (Salgado et al., 2012). In the present work, we initially evaluated the current design of PAR game with the Semiotic Inspection Method (SIM) (de Souza & Leitao, 2009); then, we performed an evaluation, by inspection, of PAR game with CVM. This evaluation allowed us to explore specific aspects of the potential intercultural experience of users with Autism in the game. This inspection led us to the redesign of the collaborative strategies by focusing on intercultural issues.

These evaluation process allowed us to: a) Identify the users' degree of immersion in the collaborative culture in each phase of the PAR game and in each collaborative strategy; and b) Perform a contrast between the concepts considered in the initial design of PAR game and the concepts obtained by using CVM to identify the necessary adjustments in the collaborative strategies to achieve a gradual immersion in the collaborative culture.

In the next section, we present related work. Subsequently, we discuss the cultural approximation approach proposed by CVM. In the methodology section, we detail the steps followed in the analysis of collaborative strategies of PAR game with the CVM. Later, we describe the PAR game, the evaluation by inspection with the SIM, and the analysis with the

CVM. Then, we present the results and propose new collaborative strategies to use in the design of collaborative applications for users with Autism. Finally, we present the conclusions.

Related Work

Collaborative applications in multitouch interfaces for users with HFA (Battocchi et al., 2009; Bauminger et al., 2007; Giusti el al., 2011) use different strategies to restrict the interaction with the application to motivate the collaboration and social interaction skills. The *Collaborative Puzzle* game (Battocchi et al., 2009), for example, uses the *Enforced Collaboration Paradigm* that requires the joint-performance of two users to move each piece of a puzzle. This presented a positive contribution in the collaboration and social interaction skills among the users evaluated.

Enforced Collaboration is also used in the *Story Table* application (Bauminger et al., 2007), which requires the interaction of two users with HFA to build a story. The authors found that the design of this type of application for multitouch tabletop has considerable advantages to the improvement of social behavior and acquisition of communication skills.

Joint In-Suite (Giusti et al., 2011), in turn, is a set of games that includes four restricted collaboration patterns: *Choosing together* (two or more users choose one same object), *restrictions on objects* (different restrictions to move the objects), *different role* (users perform different roles) and *ownership* (users have property on objects, which must be negotiated). The authors conclude that users with HFA learned and understood the importance of collaboration during the games.

In the HCI literature, Marcus (2001) highlights the importance of intercultural aspects in the interfaces design because they can lead to conceive other vision of usability, this is because the cultural aspects influences on the way users think, act, and feel. Most of intercultural aspects used in HCI studies refer to internationalization-localization of interfaces (del Galdo & Nielsen, 1996; Fernandes, 1995; Marcus, 2001). For example, Marcus (2001) indicates the importance of considering language cultural aspects in the design of website portals, because although most of the websites are in English language, there is a large percentage of users that are non-English speaking. Similarly, Fernandes (1995) describes some cultural issues which must be considered in the interfaces design, such as, language, social context, time and date formats, currency, units of measure, cultural values, symbols and aesthetics. In turn, Salgado and colleagues (2012) propose a set of conceptual metaphors that aims at assisting HCI designers in the development of cross-cultural systems.

In the psychological studies in the area of Autism, the intercultural aspects treated relate to cultural issues of each individual with Autism inside their location and social environment (Daley, 2002; Wakabayashi et al., 2006), which affect his/her diagnostic criteria, treatment, family functioning, community, socialization, and legal issues (Daley, 2002). However, we do not found intercultural studies that address aspects of Autism in HCI, or that discuss different issues to location-internationalization, such as the culture of collaboration treated in this work.

Cultural Approximation Approach

In this section, we briefly present the Semiotic foundations we adopted to consider intercultural aspects in the design of applications for users with Autism. We also explain the

CVM conceptual tool, which contributes in the inclusion of these aspects in the HCI design process.

Cultural Contextualization

The inclusion of intercultural aspects in the HCI design process of our application required the adoption of consistent perspectives on what constitute culture and the semiotic foundations of CVM. According to Eco (1976), Semiotic is a discipline that studies the cultural events from the signification and communication. Signification is the process whereby the sets of signs, defined as anything that means something to someone, are established based on social and cultural conventions. Communication is the process by which people produce messages formed by signs with the intention of expressing, through some media, certain contents. These messages are understood by interlocutors according to their signification systems.

The semiotic process is present in both people with and without autism. Orrú (2008) defends the cultural-historical approach of Vygotsky, to include the semiotic in the work with people with autism: "*A person with autism is a social subject, which is built in the social, cultural and historical relations through the mediation of another subject and the existing signs in that mediation ... conceiving the human as a person eminently symbolic.*"
We have thus chosen Geertz's (1973) semiotic conceptualization of culture. The anthropologist outlines culture as "*… a man is an animal suspended in webs of significance he himself has spun,*" he states "*I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretative one in search of meaning.*"

CVM inherits Eco's definitions of signification and communication process. This conceptual tool helped us in the redesign of collaborative strategies of the collaborative game PAR. Our focus was on the diversity of meanings communicated through the interface between designers and users to make the application not only appropriate to the cultural characteristics of the users, but also as mediator of the culture of collaboration.

Cultural Viewpoint Metaphors (CVM)

CVM (Salgado et al., 2012) is a SE (de Souza, 2005) conceptual tool composed by five metaphors that aims at assisting HCI designers while composing interactive discourses in cross-cultural systems, i.e., systems whose designers explicitly want to support and promote different levels of intercultural contact between the users. According to Salgado and colleagues (2012), CVM lead HCI evaluators and designers to conceive cross-cultural systems as a journey and users as travelers. CVM represent a continuum of cultural approximation from the user culture to a foreign culture (Figure 1).
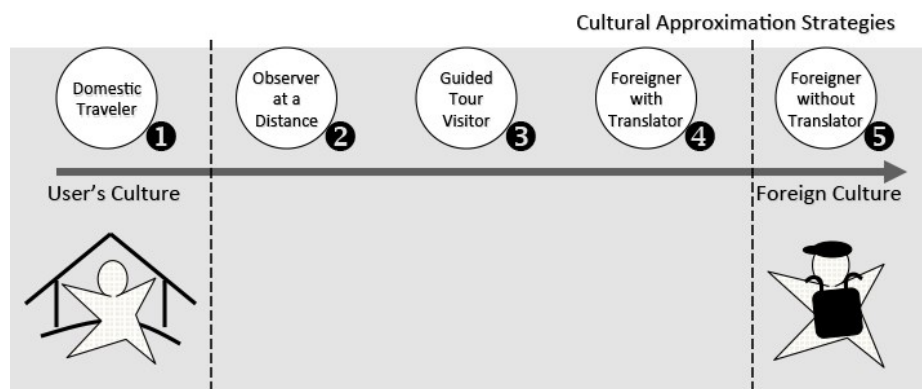

Figure 1. CVM to build of the cross-cultural *meta*communication (Salgado et al., 2012)
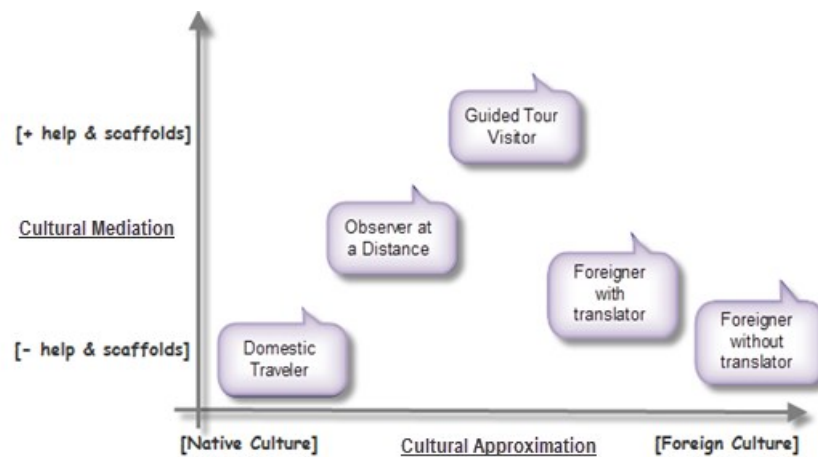
Figure 2. Distribution of CMV according to level of approximation and mediation cultural (Salgado et al. 2012)

Each metaphor represents a different level of approximation of the user to the other culture. The *domestic traveler* metaphor represents the cultural isolation, and the *foreigner without translator* metaphor represents the cultural immersion. The three intermediate metaphors mark different levels of cultural mediation.

The adoption of each metaphor in the HCI design is characterized by the use and the way in which cultural variables (language and cultural practices) of the user culture (native) or the visited culture (foreign) are presented and combined in the application interface. In the *domestic traveler* metaphor the users can feel in their own culture, just whether they haven't contact with markers from a foreign culture: language and cultural practices are native. In the *observer at a distance* metaphor, language and cultural practices are also native, but the cultural markers of another culture are shown to users as information, although the goal is to lead the user to a distant experience of a foreign culture. In the *guided tour visitor* metaphor the cultural markers of a foreign culture are presented in a way that contrasts to the user's culture. Users will be close to another culture, but will be guided on their journey through their native language and foreign cultural practice. In the *foreigner with translator* metaphor the cultural markers of a foreign culture are shown to users in the same way as they would be presented to native users of that culture. In this case, the users experiment directly another culture, but still have language translations. Finally, in the *foreigner without translator* metaphor, the users experiment another culture as native culture, without any cultural mediation: language and cultural practice are foreign.

Figure 2 shows the effects desired in the levels of cultural approximation (x-axis) potentially achieved with the levels of cultural mediation prescribed in the definition of each metaphor (y-axis). The greater the help or scaffolds level of the cultural markers, the greater the cultural mediation level in the approximation of the user to the other culture. In the next section, we present how we use the CVM in the redefinition of collaborative strategies of the PAR game.

Methodology

We have adopted non-predictive and interpretive methods of SE (de Souza, 2005), SIM and CVM, usually used in qualitative researches. Qualitative methods are particularly suitable for this type of studies, which aims at analyzing the results obtained in previous studies in depth and reflect about alternatives to redefine the collaborative strategies. We adopted

these methods because they provided us the resources to research and to make decisions about the reorganization of cultural choices in the composition of the communicative message of PAR game and the redefinition of collaborative strategies.

In the first step of this research, PAR game was evaluated with five youths with autism (three boys and two girls) with ages between 10 and 17 years. This evaluation showed that users had some difficulties to easily understand the collaborative activities of the game (Silva et al., 2014). Then, we decided to improve these collaborative strategies of the game as the second step of this research. For this purpose, we started with a detailed inspection of the game based on cultural aspects and then redefined the collaboration strategies of the game. This was accomplished following the steps below:

1. Analysis by inspection of the communication strategy of the collaborative culture in the initial design of PAR game, using the SIM, and reconstruction of the communicative message of PAR designer.
   a) Identification, from the results of the inspection, of the relation between the signs used in the interface and the "signification system" of the users, and how the "culture of collaboration" is being communicated in the PAR interface with the CVM.
   b) Analysis of the cultural variables in each collaborative strategy using the CVM to identify the level of approximation of the users to the "signification system" of the PAR game and to the "culture of collaboration".

2. Identification of congruencies and divergences among the communicative strategies of both the initial intention of PAR game and the intention using the CVM.

3. Redefinition of collaborative strategies with aspects obtained from the analysis with the CVM.

Thus, we defined the necessary modifications to unify and improve the collaborative strategies in order to offer to users a gradual approximation to collaborative culture in an environment easily identifiable.

Analysis of the Communication Strategy of PAR Game

In this section, we present the analysis process of the cultural communication strategy of PAR: a multitouch collaborative game (Silva et al., 2014). Initially, we describe the PAR game and its collaborative strategies. Then, we analyze PAR game using CVM.

Multitouch Collaborative Game PAR

PAR game was designed following requirements of a group of users with Autism. We proposed four collaborative strategies based on these requirements and on the strategies proposed in previous studies for users with HFA (Battocchi et al., 2009; Bauminger et al., 2007; Giusti el al., 2011). Our users (boys and girls) like sports, especially soccer; they enjoy technology and innovative tools to learn; they require interesting and activities easy to understand.

PAR has three phases of collaborative difficulty. In each phase one restricted collaborative strategy was included, which determine this difficulty, together with an unrestricted strategy, which allow the users to perform freely collaborative actions after they have interacted with the restricted environment.

In the PAR game, two users (user 1 and user 2) are located around the multitouch tabletop to collaborate face-to-face (Figure 3). The three phases of PAR are based on a single objective, which is to get the pieces of uniforms and to dress the soccer players of a team.

The sports pieces: t-shirt, shorts and sneakers, are randomly distributed in three higher shelves of a warehouse. These pieces need to be taken down so the players can wear them. On the side of each shelf there is a box. This box serves as a container into which the user must put each piece of the uniform to be taken down. In the lower part of the warehouse there is a cart with three spaces; each space is able to receive any piece of a uniform. When the cart is full, it is necessary to take it to the parking lot and to give the pieces one by one to the player in a row. After the parts are delivered, the user must return the cart to receive three more parts for the next player to wear and so on until all players are wearing the team uniform and are ready for the game.

First phase. Passive Sharing Strategy (PSS): user 1 should take a piece and put it in the box on the shelf, and the box will descend with the piece. User 2 should move the cart and take it to the shelf of the descending box to receive the piece sent by user 1. Likewise, user 1 should send the second piece of the uniform of a player, from any shelf, while user 2 moves the cart to receive it (Figure 3a). When the cart is filled with three pieces, user 2 should move the cart to the parking lot.

Second phase. Active Sharing Strategy (ASS): user 1 must have information of the sport piece that should be sent at each time. User 2 should ask for any piece by pressing a button. User 1 should put the piece requested by the partner in the box; this piece can be in any of the three shelves, so user 1 should locate the piece, take it and put it in the box. User 2 should move the cart to the shelf of the piece being sent to be able to receive it (Figure 3b). Similarly, user 2 should ask for the two missing pieces to fill the cart and take it to the parking lot.

Third phase. Joint-Performance Strategy (JPS): in addition to what was described in the previous phases, in this phase the boxes are closed at the time that each piece is requested. So, it is necessary that user 2 helps by pressing a button to open the boxes while user 1 takes and puts the piece requested in the box. At the moment user 1 takes the piece, a voice is heard stating: Help me by pressing the yellow button. User 2 must press that button while user 1 puts one piece into the box (Figure 3c).

Three phases. Unrestricted Interaction Strategy (UIS): in the three previous phases, after the cart is placed in the parking area the UIS is applied, where both users can take the pieces of the cart to suit the player. Each user may take any piece and in any order to dress the soccer player (Figure 3d). At this moment a message will be displayed to users informing them of the number of soccer players dressed and an option of continuing to dress the next soccer player. User 2 must then take the cart from the parking lot and return to the lower part of the warehouse to continue asking and receiving sports pieces.
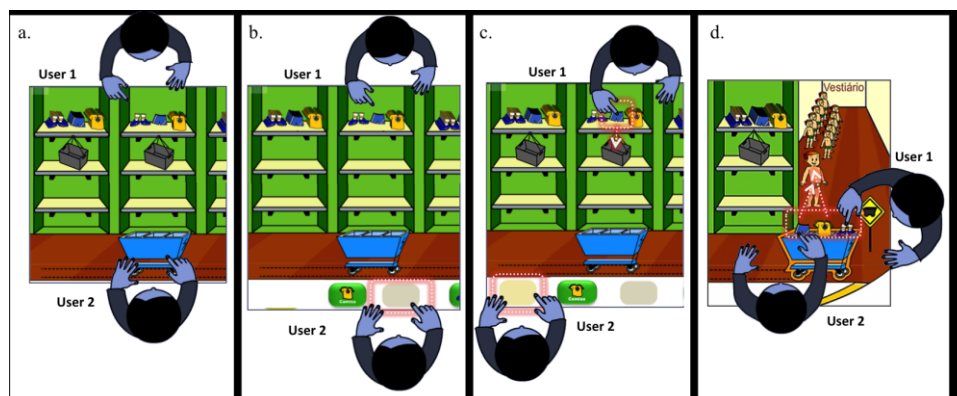

Figure 3. Collaborative strategies in each phase of PAR game: a. PSS, b. ASS, c. JPS, d. UIS

Semiotic Inspection of PAR game and its characterization with CVM

We obtained the communicative intention of the initial design of PAR game through the reconstruction of their *meta*communication message, as proposed by the SIM (de Souza & Leitao, 2009): "*Here is my understanding [the designer's] of who you are [users], what I've learned you want or need to do, in which preferred ways, and why. This is the system that I have therefore designed for you, and this is the way you can or should use it in order to fulfill a range of purposes that fall within this vision*".

The metamessage of the initial intention of the collaborative strategies is: "*I learned (designer) that you are (users) boys and girls that need to stimulate your collaborative skills through easy and didactic ways. You need and prefer that information be provided with pictures, sounds, animations, videos, and colors, which you will easily identify to help you in the orientation and performance of activities in the game. However, you also need to identify new elements indirectly without interfering your interaction with the game. You need to share resources to identify that a collaborative activity is necessary. You need to gradually identify this need for collaboration, so that you can adapt in the gradual learning of collaboration with your partner*".

This metamessage suggests that the general communication strategy of PAR game is to approximate the users with Autism to something they don´t know (the culture of collaboration) by means of signs in the interface that are part of their signification system. Thus, these signs must measure their approximation to the culture of collaboration. We called "*approximation to the signification system*" the strategy of using certain signs to contribute in the interaction of user with the system. We called "*approximation to the culture of collaboration*" the ways used in the collaborative strategies (through the signs) to approximate to the users to the culture of collaboration. We defined the cultural variables of the organization of interactive discourse as detailed in Table 1.

In the "approximation to the signification system" strategy signs recognized by users were used to facilitate their interaction in the game. We categorized this intention as a use case of the *domestic traveler* metaphor. Together with these signs, we also applied some signs not-recognized by the users, aiming to motivate them to correlate these signs and to find some meaning, and thus, minimally contributing with the enrichment of their current signification system, but without disturbing their interaction with the game. We categorize this intention as a use case of the *observer at a distance* metaphor.

In the "approximation to the culture of collaboration" strategy, the intention is to gradually lead the users to the culture of collaboration through each collaborative strategy. The categorization of this intention is detailed in Table 2.

The following subsections describe both the inspection of signs and the analysis of the communicative strategies (signification system and culture of collaboration) with the CVM.

Table 1. Cultural variables of collaborative strategies

	Language	Cultural Practice
Signification System	Set of signs in the interface	User-System Interaction
Culture of Collaboration		Collaborative Activities

Table 2. Intention of approximation of the users to the "signification system" and to the "culture of collaboration" in the initial design of PAR game

Collaborative strategies	Intention in the signification system	Intention in the culture of collaboration
PSS		Observer at a distance
ASS	Domestic traveler and/or observer at a distance	Guided tour visitor
JPS		Foreigner with translator
UIS		Foreigner without translator

Passive Sharing Strategy (PSS)

1. Approximation to the Signification System

In PSS the interface has the following signs: sports uniform (t-shirt, shorts and sneakers), the boxes, the cart and the help button (Figure 4a.b.c.d). The users easily recognize these signs, and they can feel in a familiar environment. The elements can be easily touchable due to their size and position in the multitouch interface. These aspects were categorized as a use case of the *domestic traveler* metaphor.

The cart design (Figure 4c) is recognized by users because its form is similar to a supermarket car. Then, the users can feel as *domestic travelers*. However, the parking is not a familiar sign; its form is not related with any element in the daily life of the users. This should lead them to a "foreign" interaction with the system. So, to avoid it, other signs that help the users to assimilate the expression and content of the new element were used, these are: the parking outline with a similar form to the cart, the conventional parking symbol, and the yellow light flashing on parking (Figure 4e). This set of signs allows to approximate to the user to this culture by contrast occurred between known and unknown, categorizing it as *guided tour visitor*.

We categorize the label "parking" (Figure 4e) as a use case of *observer at a distance* metaphor because it was designed only as additional information of the element without the intention of interfering in the interaction of user with the system. Some forms of signs mediation provided to users, slightly distance them from domestic traveler. This has the intention of facilitate their interaction with the game with traces of collaborative culture.
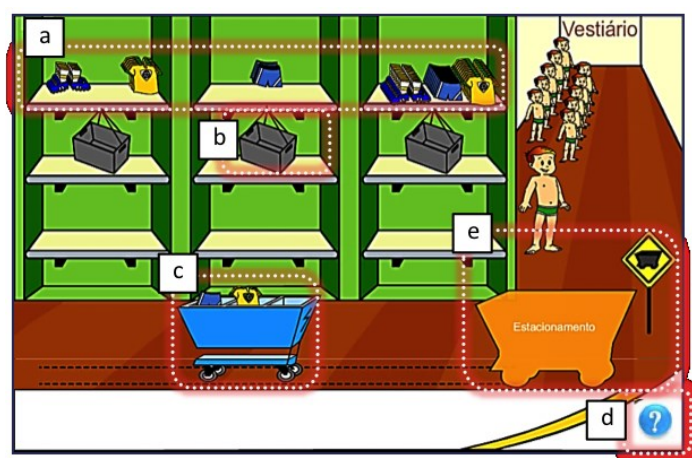

Figure 4. Interface elements in the PSS. a. Pieces of uniforms, b. Boxes, c. Cart, d. Help button, e. Parking area

2. *Approximation to the Culture of Collaboration*

In PSS no help was provided to guide the users to interact with the system, aiming that they find themselves ways to collaborate through verbal or gestural orientations from one to another. In this sense, we categorize this aspect as a use case of the *foreigner with translator* metaphor, because the users have directly experience with the collaborative culture with elements designed in their own language (according to their signification system). However, to facilitate this "foreigner" process, a therapist was present to guide them during the interaction with the game. Although this guidance is not part of the system, the users can feel as *guided tour visitors***.**

The system has a help button that is available all the time (Figure 4d). When this button is touched, the system presents a video that shows how to perform the collaborative activity, so the users feel as *observers at a distance*, because they are identifying far away the collaboration process in the game; they are not inside it. This categorization suggest that, although providing a minimum amount of roles for interaction, the users are more close to the culture of collaboration than intended with the PSS in the initial design (Figure 2).

The *guided tour visitor* metaphor, corresponding to the guidance offered by the therapist does not impose changes in design, because the presence of the therapist is essential during the game to support users and enable them to feel in a comfortable environment. Thus, this metaphor will not be analyzed again in the following phases of PAR game.

Active Sharing Strategy (ASS)

In the ASS three buttons are provided to exchange information. User 1 must ask for a piece of a uniform pressing the respective button (Figure 5a).

1. *Approximation to the Signification System*

The buttons have a conventional design of computational applications that users can easily identify. The state of buttons is active (touch me) and inactive (non-touch me) (Figure 5). The active state is complemented with a picture included in each button (Figure 5a). The user can relate the picture with the real piece that she/he wants to receive, and then she/he touches a button to get a response from the partner. This set of signs facilitates the users' interaction with the game, and they can feel as *domestic travelers*. The buttons also have labels, although the users can´t read, they can begin to relate these labels with the figure in the button. These signs (labels) invite to the users to try identifying the labels as being part of the observed images, allowing the user to feel like an *observer at a distance*. This analysis confirms the initial communication strategy of the PAR game: elements offered in this collaborative strategy remain in the cultural practice of the user.

Figure 5. Elements in ASS. a. Active buttons to ask for pieces, b. Inactive button

Figure 6. Elements for collaboration in JPS. a. Close boxes, b. Help button, c. Open boxes

2. Approximation to the Culture of Collaboration

The buttons available in this phase strengthen the collaboration and encourage users to be more attentive to perform their respective tasks. The collaborative activity is guided with signs, sounds, and voice messages. Therefore, users experience a collaborative culture being guided in this process, feeling like as *guided tour visitors*. This classification confirms the initial communication strategy in the ASS, therefore modifications in this phase are not necessary.

Joint-Performance Strategy (JPS)

In JPS boxes are initially closed (Figure 6a), and there is a help button that allows opening these boxes. The joint-performance is completed when a user touches the yellow button while the other user takes and puts the piece of a uniform in a box (Figure 6).

1. Approximation to the Signification System

The design of closed boxes is easily recognized by the users (Figure 6a), but the inclusion of boxes states (closed, open) can cause some disruption in the interaction on these elements because the users have difficult to quickly change their conception about some signs. To decrease this disruption, the information is presented through a set of elements that users could easily identify (voice messages about the boxes state, help button and flashing light on this button) and that help them to see the new state of the boxes (Figure 6c). We can say that in this environment the users can feel as *foreigners with translator*. This categorization suggests an adjustment in this respect to not disrupt the interaction of users with the system, still allowing that collaboration is transparent.

2. Approximation to the Culture of Collaboration

The new elements allow that the users directly experience the collaborative culture. The orientations offered during the interaction (voice messages and flashing light button) are the linguistic translations that users need to approximate to this collaboration, feeling like *foreigners with translator*. This suggests that the cultural markers approximate even more to the collaborative culture as expected in this phase. Then, these signs need be improved to relate with the approximation to the signification system to allow the goal in this phase.

Unrestricted Interaction Strategy (UIS)

In the UIS the users take the pieces of the uniform and put them on the soccer player, as show in Figure 3d.

1. Approximation to the Signification System

Both the locker room and the soccer players are elements known by users. So, the users can feel as *domestic travelers*. Similarly to other labels included in the game, we categorize the label "Locker Room" as a case of the *observer at a distance* metaphor, which doesn't distance the users from their comfortable environment interaction.

2. Approximation to the Culture of Collaboration

The UIS don't have any kind of restriction on interaction objects to dress the soccer players; therefore the users can feel as *foreigners without translator*. The users are immersed in a collaborative culture without any kind of information that guides them to perform the activity collaboratively. This categorization with CVM suggests agreement with the communicative strategy of the initial design in the PAR, thus, this doesn't require changes.

Results of the analysis

In this section, we present a contrast between the initial communicative intention of PAR game and the communicative intention of PAR game obtained with CVM. We then could propose the necessary changes to achieve a new set of collaborative strategies that include intercultural aspects.

According to the above analysis, PAR game has signs in the interface, which make users feel in a confortable environment. According to the evaluation performed with CVM, the approximation to the signification system (Table 3) was consistent with the initial intention in the collaborative strategies PSS, ASS, and UIS. The JPS isn't consistent, requiring modifications to lead the users to feel comfortable during the game. Regarding the approximation to the culture of the collaboration, we found that the collaborative strategies ASS, JPS, and UIS offer a gradual approximation as intended in the initial design of the PAR game (Table 3). Thus, we considered necessary to make relevant improvements just in PSS, which does not meet this requirement.

Changes suggested by CVM

We describe below the modifications suggested in the design of PAR game, in which the initial intention of the game disagree with the analysis with CVM (Table 3).

Table 3. Communicative strategies in the PAR Game. Initial intention and intention with CVM

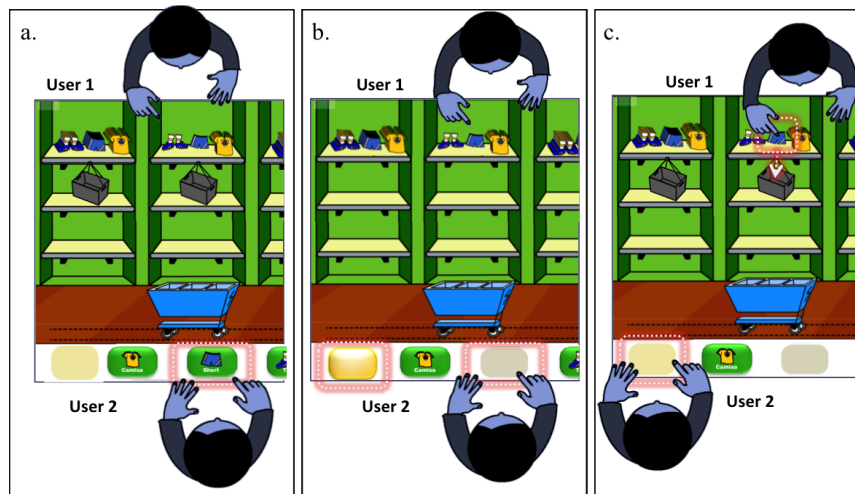| Collaborative strategy	Initial intention of PAR game	Intention of PAR with CVM
1. Approximation to the signification system		
PSS, ASS, and UIS	Domestic traveler/observer at a distance	Domestic traveler/observer at a distance
JPS		Foreigner with translator
2. Approximation to the culture of collaboration		
PSS	Observer at a distance	Observer at a distance and Foreigner with translator
ASS	Guided tour visitor	Guided tour visitor
JPS	Foreigner with translator	Foreigner with translator
UIS	Foreigner without translator	Foreigner without translator

Figure 7. Design in the interface of the JPS with the CVM. a. Initial state of interface, b. State when the piece is asked, c. State in the joint-performance of users on elements

Approximation to the Signification System (Changes in JPS)

As explained in the analysis of the JPS, the environment generated by the change of the boxes state (closed and open) is categorized as a case of *foreign with translator* metaphor. We propose to change from this state to another with visible and invisible boxes. Thus, the signs that represent the boxes remain the same during all phases of the PAR game; they change just to visible or invisible. With the proposed change, the open boxes are visible (Figure 7a), then, when user 2 requests a piece of a uniform, the boxes change to invisible and the yellow button is active (Figure 7b). When the user 2 is pressing the yellow button, the boxes again are visible, and the user 1 can put the piece in the respective box (Figure 7c.).

Moreover, the signs available in the previous design to guide users (voice messages, yellow button, flashing light on this button) still will be available, so that the users perform a collaborative activity without confusion.

Approximation to the Culture of Collaboration (Changes in PSS)

In PSS, it is necessary make modifications so that users can feel as *observers at a distance*. Then, at the beginning of the game, a video shows step by step the interaction that users should do. This video has a function similar to the help button available all the time in the game, which also puts users in an *observer at a distance* environment.

In addition, the users will be guided by the system in each interaction during the game through an animation. This animation shows how the users can perform each action at the same time that the user performs that action. Thus, the animation shows to user 1 the steps that she/he must take to send the piece of uniform (Figure 8a); when the piece is descending, the animation shows to user 2 the steps to take and move the car, and to receive the piece (Figure 8b).

Thus, the cultural mediation will be more effective in order to contribute in the approximation of the user to the "culture of the collaboration". This strategy aims that users can feel as *guided tour visitors*, according to the distribution of CVM in Figure 2. This environment also has traces of *observer at a distance* metaphor, because the users watch the videos with instructions. Thus, the categorization "foreign with translator" in the initial design of PSS is transformed into both *guided tour visitor* and *observer at a distance*.
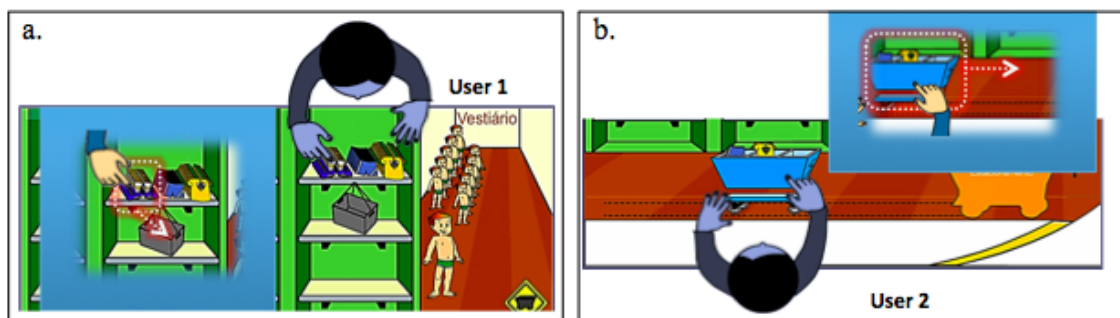
Figure 8. Animation that guide the user in each interaction on interface

Collaboration Strategies Proposed

With the changes proposed in the design of PAR game, we suggest the following collaborative strategies, which can be applied in the design of other collaborative applications for users with autism.

PSS guided at a distance: This suggests a minimum resources sharing between users through their interaction on the game elements. This sharing is supported by an animation that is shown in parallel to the actions of the users. The users watch the animation that explains how and when sharing resources with their partners.

ASS minimally guided: In this, in addition to PSS, there is an exchange of information to achieve a certain objective. The collaboration is obtained through action - response - action from one user to another, where the response of a user is given according to the information received by their partner action. ASS offers simpler guidance, through symbols that guide the users in cooperation during the exchange of information.

JPS with translator: JPS combines the active sharing with synchronous actions of users to force more collaboration. Users experience the culture of collaboration with directions about how to collaborate.

UIS and without translator: This does not have restricted roles for each user or restrictions on the game objects, allowing users to immerse themselves in the culture of collaboration through a free play on the objects available.

Conclusions

The analysis performed in this study aimed to modify the design of the collaborative strategies of game PAR, in order to approximate to the users with Autism to the culture of collaboration, which is a "foreign" culture for them, by their difficulties in this area.

We use the conceptual tool CVM (Salgado et al., 2012) of the SE (de Souza, 2005) that supports the construction of interactive discourse of cross-cultural systems. CVM helped both in the understanding of the cultural communicative strategy of the PAR game and in their redefinition, where the game offers an affordable environment for users as they slowly immerse in the collaborative culture.

The results show that the CVM addressed the modification of the collaborative strategies to promote a better interaction environment, considering the cultural characteristics of the users with Autism. The next step of this research is to apply the results of this study in an empirical study involving users with Autism to identify how they conceive the culture of

collaboration in each collaborative strategy included in the game. We suggest that CVM should be applied in the design of other applications aimed at users with special needs.

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