The User in the Group

Evaluating the Effects of Autonomous Group Dynamics

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ABSTRACT

Autonomous characters in virtual environments have the potential to improve the interaction experience of users, specially, their social experience. This effect is driven by the interactions occurring between users and the autonomous characters, that in certain scenarios can be in the context of a group. However, for these group interactions to be successful, it is not enough to assure that the autonomous characters behave in a coherent manner from an individual perspective, but it is also necessary that they exhibit behaviours that are coherent with the group composition, context and structure. Therefore, we have developed a model to support believable group dynamics of autonomous characters, inspired in theories developed in human social psychological sciences. This model defines the knowledge that each individual should build about the others and about the group it belongs, and how this knowledge drives their interactions in the group. The model was integrated in the mind of the autonomous characters that perform a collaborative task, in a computer game, with a human player. The game was used in a study that showed that players' interaction experience was better when interaction with groups that followed our model, namely, regarding trust and social identification with the group. In addition, we found some evidence that players prefer playing in groups that have higher level of conflict.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces—*Theory and models, Evaluation*; J.4 [**Social and Behavioural Sciences**]: Sociology

General Terms

Human Factors, Design, Experimentation

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Autonomous characters, group dynamics, human-computer interaction, user studies

1. INTRODUCTION

The use of autonomous synthetic characters as an artifact for user's interaction is getting more and more common. In particular, their use is very important in 3D virtual environments, since they have the potential to create a social field that enhances the user's interaction experience [6]. This effect is due to the fact that users have social expectations when interacting with computers and other media and apply, in these interactions, similar social rules as they apply in human to human interactions [22].

Furthermore, virtual environments have evolved in such a way that enable several users and autonomous synthetic characters to interact simultaneously in the same virtual space, for example, in internet communities and some computer games. In addition, these interactive scenarios often present tasks to the participants that must be solved collaboratively. This is the case, for instance, of computer role-playing games where several players form parties of adventures to undertake the challenges and quests of the game's world.

However, following Bates[7], we can state that the interactions between the users and the autonomous synthetic characters will only be positive and effective, in these collaborative group scenarios, if the characters are able to show a coherent and believable behaviour in the group.

Furthermore, the research conducted on autonomous characters is usually centered on the interactions between a user and a single character [8] [21] or on the interactions of the synthetic characters among themselves [27] [25] without considering the user within the group and without a common collaborative task.

To engage the user in the group, we argue that it is not enough to assure that the autonomous members behave in a coherent manner from an individual perspective, but it is also necessary that they exhibit behaviours that are coherent with the group composition, context and structure.

To achieve this, we created a model to support the creation of believable dynamics of a group on autonomous characters. The model was inspired by theories developed in human social psychological sciences, and defines the knowledge that each individual should build about the others and the group, and how this knowledge drives their interactions in the group.

To test the effects of this model we have developed a computer game that places the user in a group with four autonomous synthetic characters with a common collaborative task. Using this game, we have conducted one study with the participation of several students of our university. The goal was to assess the effects of using our model to drive the dynamics of the group in the users' satisfaction with the game and their trust and social identification with the group.

This paper is organiazed as follows. First, we present some related work. Then, we briefly describe the model that was developed. Afterwards, we describe the game that was created to test the model. Then, we present the study that was conducted and its results. We finished with some conclusions and remarks for future work.

2. RELATED WORK

The problem of multiple autonomous synthetic characters that interact in a virtual environment has been previously addressed by several researchers. The first example of this can be found on Reynolds' Boids [23], which implements a flocking behaviour in a group of flying creatures. Research concerning the generation of crowds [19] is another example of this line of work. A well known example is "The Lord of the Rings" trilogy [20] that include numerous fighting scenes involving armies of thousands of warriors, the major part of these being played by synthetic actors.

The Boids' flocking behaviour and crowd generation make use of an emergent group dynamics and result in a believable life-like group behaviour. However, characters in these examples do not have a deep social awareness and lack the ability to build social relations, which we believe to be essential for the interaction with a user.

Another example is the AlphaWolf [27] system, which simulates the behaviour of a pack of six grey wolves. In this system, the different synthetic characters are able to build domination-submission relationships. These relations are built in the form of emotional memories that drive the characters' behaviour. In addition, three users can interact with the system and influence the behaviour of three of the wolves. AlphaWolf has successfully implemented a believable simulation of the group interactions in a pack of wolves, and has engaged the user in such interactions. However, the user and the synthetic characters do not engage in the resolution of a collaborative task.

Schmitt and Rist [25] developed a model of virtual group dynamics for small group negotiations. In their system, users delegate the task of scheduling their appointment meetings to a virtual agent. The agents will later meet in an arena and together negotiate the meetings' times and dates. Each agent has an individual personality and builds social attraction relations with the others. These relations and personality guide the agents' interactions and support the generation of the negotiation dialogues. In the end, the dialogues are played for the users by a cast of synthetic characters. The believability of the group dynamics is a key factor in this example as it supports the believability of the agents' dialogues. But, users do not directly engage in the group interactions.

A more recent work, PsychSim [16] addresses some issues regarding the dynamics of social influence. PsychSim is an agent-based modelling tool that allows an end-user to quickly construct a social scenario, where a diverse set of entities, either groups or individuals, interact and communicate among themselves. Furthermore, each entity has its own goals, relationships (e.g., friendship, hostility, authority) with other entities, private beliefs and mental models about other entities. Then, based on the scenario specified, the tool simulates the social dynamics as it generates the behavior for all the entities. In addition, it provides explanations of the result of the simulation in terms of each entitys goals and beliefs. The simulation is based on a model of influence grounded on the effects of communication and a recursive theory of mind.

STEVE [24] is an example of a system where the users engage with a group of synthetic characters in a collaborative task. It is used in a navy facility to train a team to handle possible malfunctions that may arise in a ship. The team can be composed of several human users and several virtual characters, which interact in a 3D virtual environment that simulates the ship and its equipment. However, in this scenario, all the interactions between the group members are related to the task and there is not the possibility for deeper social engagement.

Computer Role Playing Games (RPGs), are another example of systems that engage the users in a group of autonomous synthetic characters that perform a collaborative task. However, since the social skills of the autonomous characters are usually weak, they only perform simple roles and are not deeply involved in the group task, or if they are, their autonomy is limited, as the user controls most of their actions and decisions.

3. THE MODEL

Our goal is to engage the user in groups of autonomous characters that are committed to the resolution of collaborative tasks. However, as shown in the previous examples, in the current systems the user's interaction with such groups is very limited. Often, the autonomous characters lack the ability to achieve a proper social engagement with the group and have their autonomy restricted.

To tackle these problems, we have developed a model (Synthetic Group Dynamics Model), based on studies of human group dynamics found on social sciences [9] [5] [18] [26], to support the behaviour of the autonomous members in the group. This model defines the knowledge that each autonomous character should build about the group and how this knowledge influences their behaviour (check [**?**] for more details).

This knowledge is divided in three different levels:

1. **The Individual Level:** in this level are defined the individual characteristics of each member. This includes the personality of the member, which is defined in terms of the first two dimensions of the Five Factor Model [17] (*Extraversion* and *Agreeableness*) and the member's skills in relation to the group's tasks.

2. **The Group Level:** this level models the group composition and its underlying structure as well as the members' attitude towards the group. The group's structure emerges from the relations established between the members and is modeled in two different

dimensions: (1) the *structure of power* based on the emergent relations of social influence, and (2) the *sociometric structure* based on the emergent relations of social attraction. The member's attitude towards the group is modeled in terms of her/his *motivation* to participate in the group.

In addition, from the structure of the group, we derive the relative *position* of each member in the group, which, reflects her/his relative significance in the group and, thus, defines how important are her/his contributions to the group and how well are they accepted. For example, actions performed by members that have better *positions* in the group have stronger effects on the group process. This position depends on the overall *social influence* that the member may exert on the others and the *attraction* that the others have for her/him. Therefore, the more relevant members in the group will be those that have gained more power and/or that are more popular.

3. **The Context Level:** this level defines the knowledge related to the environment and the nature of the group's tasks. This includes a model of the task as well as the social norms that define the acceptable and the misconducted interactions.

The dynamics of the group is observed in the interactions that occur between the group's members. On the one hand, this dynamics reflects the changes that the group interactions induce on the character's perception of the group and, therefore, on the knowledge the s/he builds about it. On the other hand, the dynamics also reflect the rules drive her/his behaviour in the group.

To support these processes we have defined a set of categories that classify the relevant interactions that occur in the group. This categorization was based on the one used on the IPA system [5] and divide the interactions in two major categories:

1. the *instrumental interactions* that are related to the group task;
2. and the *socio-emotional interactions* that are related to the group social relations.

In addition, these interactions can be classified as positive, if they convey positive reactions on the others, or negative, if they convey negative reactions (see table 1).

Type	**Positive**	**Negative**
Socio-emotional	*Agree, Encourage*	*Disagree, Discourage*
Instrumental	*Facilitate Problem, Gain Competence*	*Obstruct Problem, Loose Competence*

Table 1: The categories of interaction.

During the group process, each member observes the actions that are being executed by the others and tries to identify patterns that match each of the proposed categories. This classification is done according to the current context and depends on the individual view of each member. Thus, for example, if two members have different views concerning the group's tasks, some actions may be perceived by one member as helpful to the resolution of these tasks and, therefore, classified as *FacilitateProblem* but can be perceived by the other as disadvantageous and, therefore, classified as *ObstructProblem*.

Furthermore, when members identify the occurrence of one interaction, they react to it according to the classification that they internally gave to the interaction. These reactions are translated into changes on the perceived knowledge of the group, specially in its structure [12] [14]. For example, *instrumental* interactions are related to changes in the relations of *social influence*, thus, each member that is responsible for positive *instrumental* interactions will raise her/his *influence* over the others and will decrease it in the case of a negative *instrumental* interactions. In turn, *socio-emotional* interactions are related to changes in the relations of *social attraction*, thus, each member that is target of a positive *social-emotional* interaction will raise her/his *attraction* for the performers and will decrease it in case of a negative *social-emotional* interaction. The *motivation* of the members involved in the interaction may also improve in the case of positive interactions and decrease otherwise. These rules are resumed in table 2.

Interaction	**Mot(P)**	**Mot(T)**	**SI(P,T)**	**SA(T,P)**
Pos-Instr(P,T)	+		+	
Neg-Instr(P,T)	-		-	
Pos-SocEmot(P,T)		+		+
Neg-SocEmot(P,T)		-		-

Table 2: The effects of the interactions on motivation (Mot), social influence (SI) and social attraction (SA). P denotes the member that performs the interaction and T the target of the interaction.

Moreover, in order to keep the social relations balanced [14], the *social-emotional* interactions may have effects on a member of the group this is not directly involved in the interaction. For example, imagine that John is encouraging Frank because he failed to perform a certain task and Mary observed this event. Mary knows that Frank will increase his social attraction for John and this will lead to changes in her own relation with the two. For instance, if Mary has a positive relation with Frank then her relation with John may improve. But, if, on the other hand, she has a negative relation with Frank then her relation with John may become worse. Table 3 resumes these rules.

Interaction	**SA(O,T) > 0**	**SA(O,T) < 0**
Pos-SocEmot(P,T)	+	-
Neg-SocEmot(P,T)	-	+

Table 3: The effects of the interactions on the social attraction of an observer. The values on the table reflect the changes on SA(O,P).

The intensity of the interactions' effects depends on the *position* in the group of the members that perform them. Thus, for example, encouragements performed by members with a better *position* will increment more the target's *motivation*.

The knowledge built regarding the group, in its three different levels, regulate the behaviour of the member in the group. This is reflected in a set of conditions that determine the frequency of occurrence of each type of interaction. These conditions depend on individual characteristics, such as *motivation* and *personality*, and on the social structure of the group [26] [18] [1].

Table 4 resumes the influence of each of these variables regarding the four main categories of interaction. For example, the first three lines express the general rules for the frequency of all types of interaction, which state that: *"highly motivated agents engage in more interactions, as well as agents with a good position in the group or high extraversion"*. Another example, concerning the social relations, is expressed in line 7, which states that: *"a character will engage in more positive socio-emotional interactions towards members that have influence over him"*. Note that decisions are probablistic. The abovementioned rules only suggest the frequency of interaction. Thus, for example, a less motivated agent can perform tasks, but not very often.

Variable	SE-Pos	SE-Neg	I-Pos	I-Neg
Motivation(P)	+	+	+	+
Extraversion(P)	+	+	+	+
GroupPosition(P)	+	+	+	+
Agreeableness(P)	+	-		
GroupPosition(T)	+	-		
Influence(P, T)	-	+		
Influence(T, P)	+	-		
Attraction(P, T)	+	-		
Skills(P)			+	-

Table 4: The influence on the interactions.

4. THE GAME

The SGD Model model was used in the mind of the autonomous characters in a computer game called "Perfect Circle: the Quest for the Rainbow Pearl"[1]. The game takes the user into a fantasy world where he joins a group of four other characters to search the world for a magic item. To achieve this, the group must travel around the world through magic portals that are activated by the powers of some gemstones. Their task is to gather and manipulate the gemstones in order to get the required ones that will open the portal. (see figure 1) To achieve this, the characters need to apply their individual abilities in order to change the gems' form, size and colour. For example, if the group has two small rubies but it needs one medium sized ruby, one character can use its ability to merge the small stones into a bigger one. In addition, two or more characters can combine their efforts if they all have the same ability. As a result, the probability of success of the action becomes higher.

Furthermore, every character in the group is engaged in the same goal, thus trying to solve the same task. However, there are many ways to reach a solution, and if each of the characters follows its own, the group may never solve the task. Thus, characters have to coordinate their actions in order to follow a similar strategy in the search for the correct gems to activate the portal.

For this reason, every action that is performed in the group, concerning the resolution of the task, is discussed by the group beforehand. The discussion protocol has three different steps:

1. First, one character declares that s/he wants to take a certain action (e.g. *"I think that it will be best if I merge these two sapphires"*).

[1]This game can be downloaded from *http://web.tagus.ist.utl.pt/ rui.prada/perfect-circle/*.

Figure 1: A shapshot from the game. The group is trying to activate one of the portals in order to move further.

2. The other characters can respond to the proposal with one of the following: (1) *Agree* with the course of action; (2) *Join* the action (and agree with it) and help in the execution; (3) *Disagree* with the course of action.

3. Then, based on the opinions expressed by the group, the character decides to proceed with the execution of the action or to withdraw the proposal. If s/he decides to proceed with the action then s/he starts its execution. All other characters that have decided to join the action start their contributions to the joint execution.

The group interactions are not restricted to the execution of the task. Each member can, at any time, engage in social-emotional interactions by encouraging or discouraging the other members of the group.

5. STUDY

5.1 Participants

The experiment was conducted at our university with 24 students of computer engineering, being 20 of them male and 4 female. The subjects' age ranged between 19 and 31 years old.

5.2 Independent Variables

The experiment was conducted with two main independent variables: the use of the model SGD Model to convey the believable group dynamics and the initial structure, and consequent cohesion level, of the group.

1. **The Use of the model:** SGD Model two different versions of the game were built: one where the characters followed the model SDG Model and other where they did not. When the characters did not use the model they were not able to engage in socio-emotional interactions, except *Agree* and *Disagree* (without any socio-emotional connotation). In addition, their frequency of interaction was always constant and the decision to proceed with a proposed action was not weighted by the members' position in the group, it was a simply majority rule.

2. **The Group's Initial Structure:** subjects can start the game in a group with non neutral initial social relations, which means that the initial group can have levels of cohesion that may be either very high or very low. Two different scenarios were considered: one

where the group had neutral social relations and a second one where the members of the group disliked each other, which, took the group cohesion to very low levels. Note that this condition could only be applied when the game was run with the believable group dynamics model.

In addition, we have considered two control variables, in the sense that different levels of these might influence the relationship between the independent and dependent variables under consideration. These variables were: the subjects' personality and gaming experience.

1. **Personality:** it was previously discussed in section 3 that personality is one of the factors that influence the behaviour of people when interacting in a group. Thus, we measure the subjects personality to check if it affects the results. For example, would more cooperative subjects benefit more from the use of a believable group dynamics? Or would it be otherwise?

2. **Gaming experience:** it was considered that subjects' gaming experience, and their attraction for gaming, may change their perception of the game, and therefore may influence their evaluation. For example, subjects that play computer games more often or that like computer games a lot, may give less importance to the details of the group interaction and be more concerned with the details of the task.

5.3 Dependent Variables

To assess the quality of the subjects' interaction experience while playing the game we have measured their satisfaction with the game as well as their trust and social identification with the group, since, according to Allen et al. [2] these two variables are related to the satisfaction of people when interacting in group. Thus, the three dependent variables are:

1. **Group Trust:** people's trust on a group has a positive effect on their perceptions about their experience in the group [11], which consequently leads to a more satisfactory interaction [3].

2. **Group Identification:** according to Ashforth and Mael [4] social identification is, in addition to social trust, one of the factors that foster the members of a group to be more engaged and more satisfied with the group.

3. **Satisfaction with the Game:** computer games are supposed to be fun, thus, the user should enjoy every moment that s/he spends with the game. Hence, to improve the interaction experience, as stated in the initial hypothesis, would imply also to increase the user's fun.

5.4 Measures

To measure the variables discussed in the previous sections (5.2 and 5.3), we have referred, whenever possible, to questionnaires found in the literature and previously applied in other studies.

To measure the subjects' personality we have used a fifty items questionnaire developed by the International Personality Item Pool [13] [15] that is based on the Five Factor model of personality [17].

Concerning the computer gaming experience, we did not find any relevant studies and questionnaires that could be used in our study. Therefore, we had to design our own questionnaire. To do so, we have defined some items that are related to the ideas behind the definition of this variable, which should measure if the users like to play computer games, if they play them often and if they believe that playing computers is important. As a result, we have build a questionnaire with six different items that is shown in table 5. The Cronbach's Alpha for these items was 0.643. This, indicates that to mix three diferent ideias to measure the gamming experience might not be the best choice[2].

The Gaming Experience Questionnaire
1. I love to play computer games.
2. Playing on the computer is a waste of time.
3. I play computer games frequently.
4. The computer should only be used as a working tool.
5. I play several hours a day on the computer.
6. I do not understand those who play computer games.

Table 5: The items of the gaming experience questionnaire.

In the case of group trust we relied on the questionnaires that Allen et al.[2] used in their studies. They proposed a seven items questionnaire with five positive items and two negative. However, for consistency purposes we have only used six of these items and changed one of the items positive sentence into a negative one. The items of this questionnaire are presented in table 6. The Cronbach's Alpha for these items was 0.787.

The Group Trust Questionnaire
1. Most people on this team are honest and can be trusted.
2. Team members are always interested only in their own welfare.
3. Members in this team are always trustworthy.
4. One has to be alert or someone is likely to take advantage of you.
5. If I have a problem there is always someone to help me.
6. Nobody in the group is willing to help me with my tasks.

Table 6: The items of the group trust questionnaire.

In the case of social identification with the group we relied again on the work of Allen et al.[2], since that they also proposed a questionnaire to measure this variable. Their questionnaire is composed by five different elements all of positive nature. These items formed the base of our questionnaire, however, with two significant changes: first, some of the sentences were changed to meet our gaming scenario, and second, three of the items were changed to negative. In addition, a new positive item was added, to complete the set of six. The resultant questionnaire is shown in table 7. The Cronbach's Alpha for these items was 0.797.

We have found several questionnaires in the literature to measure the users' satisfaction with computer systems, such as the End User Computing Satisfaction questionnaire [10]. However, these questionnaires focus on questions related to the system's accuracy, ease of use and effectiveness, and do not take into account the user's joy on the experience. In fact, as stated by Wiberg [28] these classical measures are not completely appropriated for attain the users satisfaction

[2]Usually accepted values for Cronbach's Alpha are around 0.8 and higher.

The Social Identification Questionnaire
1. I feel strong ties with the members of this group.
2. I did not enjoy to play with this group.
3. I feel accepted as a member of this group.
4. I experience a sense of not belonging to this group.
5. If I play again I would like to play with the same group.
6. I am not sufficiently acknowledged in this group for my expertise.

Table 7: The items of the social identification questionnaire.

in entertainment systems. For example, if the user spends a lot of time on a particular task this is not necessarily a bad sign, since this may happen because the user is having fun with the task. For these reasons, we have developed our own questionnaire that is shown in table 8. The Cronbach's Alpha for these items was 0.739.

The Game Satisfaction Questionnaire
1. I loved to play this game.
2. I felt bored while playing the game.
3. The game was very interesting.
4. I would not suggest this game to anybody.
5. I would like to play this game again.
6. The game was too complex.

Table 8: The items of the game satisfaction questionnaire.

All questionnaires asked the subjects to rate each of its items in a scale of 1 (Totally Disagree) to 7 (Totally Agree).

5.5 Procedure

The experiment was divided into four sessions of two hours each. In each session we had six different participants each on a different computer with the *Perfect Circle* game installed. The game was installed according to three different conditions (two computers for each condition):

(C1) In the first condition the game was installed without our model for believable group dynamics.

(C2) In the second condition the game was installed with the model and the group had neutral social relation in the beginning of the game.

(C3) In the third condition the game was installed with the model but the members of the group started with negative social attraction relations, thus, the level of cohesion of the group was very low.

Furthermore, apart from the differences mentioned, all the other details were similar for the three conditions. The four autonomous characters had the same name, the same appearance, the same personality and the same skills. In addition, the sequence of the game puzzles was predefined and the same for all the subjects. This sequence was randomly generated beforehand. The subjects were selected on the fly in the beginning of each session and they chose freely which computer to use.

In the first half-hour the subjects read the game instructions that were previously distributed and filled the first part of the questionnaire, which included the items related to their gaming experience and personality.

After filling the first part of the questionnaire, the subjects could start playing the game. They first created their own character and played the game for one hour. Then, the subjects were requested to fill the second part of the questionnaire, which included the items related to the group trust, the group identification and satisfaction with the game.

This process was repeated in the four sessions, which in the end gave a sample of eight subjects for each of the conditions.

6. RESULTS

The first analysis involved testing the comparability of the three different experimental conditions regarding the participants' controls judged important: the personality traits and gaming experience. As table 9 shows, the Kruskal-Wallis test revealed no significant differences between the conditions concerning the participants gaming experience and personality traits.

	GAMING	P-I	P-II	P-III	P-IV	P-V
Chi-Square	.147	.933	.247	.094	3.089	.605
df	2	2	2	2	2	2
Asymp. Sig.	.929	.627	.884	.954	.213	.739

Table 9: Kruskal-Wallis test results concerning the comparisons between experimental conditions for gaming experience and personality traits (N = 24).

The second step involved comparing all the different experimental conditions in relation to the dependent variables used. Table 10 shows the results of the Kruskal-Wallis test to compare all the experimental conditions and reveals statistically significant differences in Trust. Furthermore, the difference between the conditions in relation to the Identification variable approaches statistical significance.

	Trust	Identification	Satisfaction
Chi-Square	6.492	5.960	4.503
df	2	2	2
Asymp. Sig.	.039	.051	.105

Table 10: Results from the Kruskal-Wallis test comparing all the experimental conditions (N=24).

The previous result, however, does not tell if all the conditions differ or if the difference comes from a particular pair of condition's comparison. In order to check out possible differences between pairs of experimental conditions a series of Mann-Whitney test were run.

Table 11 gives the results of the Mann-Whitney U comparing the condition 1 and 2. It shows that Trust is significantly higher on condition 2 (Mean Rank for condition 1 = 6.13; Mean Rank for condition 2 = 10.88).

	Trust	Identification	Satisfaction
Mann-Whitney U	13.000	16.000	20.500
Asymp. Sig. (2-tailed)	.045	.090	.226

Table 11: Results from the Mann-Whitney test comparing condition 1 and 2 (N=16).

The comparison of conditions 1 and 3 can be inspected in Table 12. The results show that Trust is once again significantly lower for condition 1 (Mean Rank for condition

1 = 5.69; Mean Rank for condition 3 = 11.31). Furthermore, Identification is also significantly lower for condition 1 (Mean Rank for condition 1 = 6; Mean Rank for condition 2 = 11).

	Trust	Identification	Satisfaction
Mann-Whitney U	9.500	12.000	24.000
Asymp. Sig. (2-tailed)	.018	.035	.397

Table 12: Results from the Mann-Whitney test comparing condition 1 and 3 (N=16).

In relation to the comparison of condition 2 and 3, Table 13 shows significant differences for Satisfaction. Participants in condition 2 were less satisfied with the game that participants in condition 3 (Mean Rank for condition 2 = 6; Mean Rank for condition 3 = 11).

	Trust	Identification	Satisfaction
Mann-Whitney U	29.500	19.500	12.000
Asymp. Sig. (2-tailed)	.792	.187	.035

Table 13: Results from the Mann-Whitney test comparing condition 2 and 3 (N=16).

The above results suggest that in this game setting the parametrisation of the agents to display a cohesive group did not bring higher satisfaction to the gamers. Furthermore, although the use of the model did increase participants' levels of Trust (when comparing condition 1 with 2 and 3) and Identification (when comparing condition 1 with 3) it did not significantly increase their levels of satisfaction. Note that if Bonferroni correction is used when comparing the 3 conditions with each other the threashold for acceptance a significant result drops to 0.017 (instead of the usual 0.05). Thus, the results described become non-significant. However, this is due to the fact that we do not have many subjects in our experiment (only 8 per condition). We believe that results are still interesting, although, we should conduct a new study with more subjects to substantiate them.

Finally, we run a series of correlations between the different dependent variables and gaming experience[3]. Table 14 shows that gaming experience correlates positively and significantly with Trust and Satisfaction but not with Identification. However, Identification is positively and significantly correlated with Trust.

When breaking the sample by conditions (see Table 15) the results suggest some interesting patterns. However, these results have to be interpreted cautiously due to the sample size - 8 participants per group. Nevertheless, one can see that gaming experience correlates positively and significantly with satisfaction for conditions 1 and 2 but not 3. Considering that the previous analysis showed that condition 3 was not less satisfying than the other conditions a possible explanation for this result is just that less experience gamers still find condition 3 strongly appealing.

Another interesting results concerns Trust. This variable is positively and significantly correlated with satisfaction in condition 2. Thus we might consider that the participants who appreciated more the Trust generated by the cohesive group were more satisfied with the game. However, it was quite surprising to find that Trust was significantly and positively correlated with Identification only for condition 3.

[3]We also run a series of similar correlations for personality traits. However, it did not show significant and meaningful results.

		Gaming	Trust	Identification
Trust	Correlation	.505(*)	-	-
	Sig. (2-tailed)	.012	-	-
Ident.	Coefficient	.258	.714(**)	-
	Sig. (2-tailed)	.224	.000	-
Satisf.	Correlation	.604(**)	.389	.376
	Sig. (2-tailed)	.002	.061	.070

(*) Correlation is significant at the 0.05 level (2-tailed).
(**) Correlation is significant at the 0.01 level (2-tailed).

Table 14: Correlation between the dependent variables (trust, identification and satisfaction) and the control gaming experience for all participants (N=24).

Cond.			Gaming	Trust	Ident
1	Trust	Correlation	.588	-	-
		Sig. (2-tailed)	.125	-	-
	Ident.	Correlation	.400	.549	-
		Sig. (2-tailed)	.326	.159	-
	Satisf.	Correlation	.831(*)	.552	.558
		Sig. (2-tailed)	.011	.156	.151
2	Trust	Correlation	.667	-	-
		Sig. (2-tailed)	.071	-	-
	Ident.	Correlation	-.096	.181	-
		Sig. (2-tailed)	.820	.668	-
	Satisf.	Correlation	.766(*)	.766(*)	.055
		Sig. (2-tailed)	.027	.027	.898
3	Trust	Correlation	.345	-	-
		Sig. (2-tailed)	.402	-	-
	Ident.	Correlation	.307	.842(**)	-
		Sig. (2-tailed)	.459	.009	-
	Satisf.	Correlation	.398	.079	.325
		Sig. (2-tailed)	.329	.853	.432

(*) Correlation is significant at the 0.05 level (2-tailed).
(**) Correlation is significant at the 0.01 level (2-tailed).

Table 15: Correlation between the dependent variables (trust, identification and satisfaction) and the control gaming experience by conditions (N=8, per condition).

7. CONCLUSIONS

We have argued that autonomous synthetic characters, when interacting in group with users, need to present a behaviour not only coherent at the individual level, but also coherent with the group. To achieve this we have developed a model that defines the knowledge that autonomous characters should build about the group and how this knowledge influences their behaviour in the group. This model was tested using a computer game that engages one user in a group of four autonomous characters that perform together to solve a common task.

The evaluation was done at our university with 24 of our students, and showed interesting results concerning the user's satisfaction with the game and their trust and social identification with the group. We found that there are significant differences in the trust and social identification between the members that played the game with and without the model. Their values were both higher when the model was used. In relation to the users' satisfaction with the game we found that if the group starts with low levels of the cohesion players have more fun playing the game. This gives us some evidence that players might prefer playing in groups that have higher level of conflict. In addition, there are some correlation between the users' trust and satisfaction with the game that may explain this difference, however, we believe that further studies should be developed to explore issues.

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