Believable Groups of Synthetic Characters

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ABSTRACT

In recent years, virtual environments have evolved from single user and single agent, to multi-user and multi-agent, all interacting, collaborating or competing with each other. This scenario created new challenges for the users' interaction with the environment, in particular for their interaction with the autonomous synthetic agents. To engage in successful and believable interactions the synthetic agents they must be able to show a coherent set of behaviours responsive to the user's actions. For example, in scenarios where users and synthetic agents interact as a group it is very important that the interactions follow a believable group dynamics. Focusing on this problem, we have developed a model that supports the dynamics of a group of synthetic agents, inspired by theories of group dynamics developed in human social psychological sciences, driven by a characterization of the different types of interactions that may occur in the group. We have implemented this model into the behaviour of autonomous synthetic characters that collaborate with the user in the resolution of collaborative tasks within a virtual environment. It was used in an experiment that showed that the model had a positive effect on the users' trust and identification with the synthetic group.

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

Keywords

Autonomous synthetic characters, group dynamics, collaboration, human-computer interaction, multi-agent systems, virtual environments

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1. INTRODUCTION

With the emergence of synthetic characters, collaborative virtual environments can now be populated, at the same time, by characters and users, all interacting, collaborating or competing with each other. However, users' interaction with the synthetic characters is not always the best, and it is only positive if the characters are able to show a coherent and believable behaviour. Believability in synthetic characters highly depends on the richness of the characters' actions and interactions, on their expressions, and more importantly on how well they lead the user to the suspension of disbelief [5].

Furthermore, humans are social animals. They live in society, get organized in groups, and even treat objects and machines in a social way. In fact, results obtained by Reeves and Nass [16] show that people's interactions with computers are fundamentally social. Thus, when building synthetic agents that interact in a multi-agent context, social awareness must be considered.

However, most approaches coming from social interaction between agents focus primarily on optimal results of the groups, such as, for example, the problem of allocation of sub-tasks. Addressing the social dynamics of a group with the concrete aim of achieving group believability is rarely done. In addition, many computer games nowadays are multi-player games that allow several users to play with several synthetic characters. However, in general, such games suffer from a limitation: the role of the system-controlled synthetic characters is very restricted. Characters do not actively participate or collaborate with the user in the challenges and tasks of the game. To do so, characters would need to have some sort of social intelligence and group awareness.

Thus, aiming at achieving believability of synthetic characters while performing in group, we argue that it is not only necessary to assure that the characters behave in a coherent manner from an individual perspective, but also that they exhibit behaviours that are coherent with the group context and structure, following a believable group dynamics. We consider that this kind of group believability can improve the users' interaction experience in entertainment or training scenarios.

To prove this argument we propose to enhance the role of these characters, making them part of the team. In order to do that we have developed a model for group dynamics that allow each individual agent to reason about the others and the group. This model, inspired by theories developed in human social psychological sciences, is driven by a characterization of the different types of interactions that may occur in the group, taking into account the socio-emotional interactions as well as the task-related ones.

We have implemented the model into the behaviour of synthetic characters that collaborate with the user in the resolution of tasks within a virtual environment (a collaborative game). We have conducted an experiment with the game and the results showed that the model had a positive effect on the users' trust and identification with the group.

This paper is organized as follows. First, we will review some related work in the area of multi-synthetic characters. Then we will describe the model of group dynamics and how it was embedded in the architecture of synthetic characters in a computer game. We will then describe an experiment and report that the use of the model has led to more identification with the group by the user, as well as more trust in the group. Finally, we will draw some conclusions.

2. RELATED WORK

The problem of multiple synthetic agents that interact in a virtual environment has been previously addressed by several researchers. The first example of this can be found on Reynolds' Boids [17], which implements a flocking behaviour in a group of flying creatures. In the same line of work we can additionally find research concerning the generation of crowds [14] that is often used in commercial systems for film creation. One well known example of this is "The Lord of the Rings" trilogy [15] 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, agents 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 [20] 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 and do not have a strong notion of group.

In a more recent work, Schmitt and Rist [19] 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.

STEVE [18] 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), such as "Star Wars: The Knights of the Old Republic"[6] or "The Temple of Elemental Evil"[21], 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. SGD MODEL: A MODEL FOR GROUP BELIEVABILITY

The proposed SGD Model (Synthetic Group Dynamics Model) is based on the principle that a character must be aware of the group and its members and should be able to build a proper social model of the group and reason with it. To build such a model, we have relied on theories of group dynamics developed in human social psychological sciences, in particular [7], [4] and [13].

In the model, we consider a *group* to be a system composed of several agents, which engage in interaction processes that drive the dynamics of the system. Agents themselves, apart from their knowledge of the task and their individual goals, also contain a model of the group, which is characterized in four different levels (see figure 1):

1. **the individual level** that defines the individual characteristics of each group member (thus, what each agent knows about the individual characteristics of the others);
2. **the group level** that defines the group and its underlying structure;
3. **the interactions level** that defines the different classes of interactions and their dynamics;
4. **the context level** that defines the environment and the nature of the tasks that the group should perform.

3.1 The Individual Level

In the individual level each agent is modelled as a unique entity and is defined by the following predicate:

$$Agent(Name, Skills, Personality) \qquad (3.1)$$

Where *Name* is a unique id of the agent, *Skills* represent the set of abilities that the agent can use in the task resolution, and *Personality* defines the agent's personality according to the Five Factor Model [12]. We have simplified the personality of our agents and have only considered two of the five factors proposed in the Five Factor Model: *extraversion* and *agreeableness*; that according to Bales[1] are associated with the ideas of dominant initiative and socio-emotional orientation.

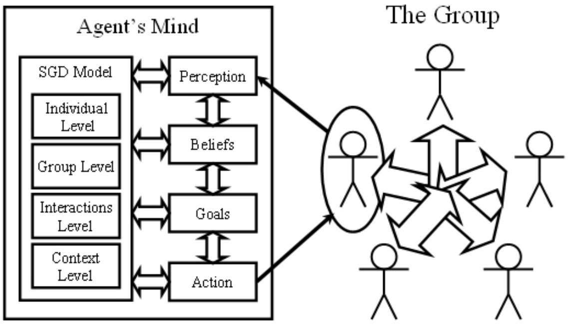

Figure 1: The agent and its social model of the group.

3.2 The Group Level

In the group level, the model considers a group and its underlying structure as well as the agents' attitude towards the group. A group is defined by the following predicate:

$$Group(Identity, Members, Structure) \tag{3.2}$$

The *Identity* defines a way of distinguishing the group in the environment, thus allowing its members to recognize and refer to it. *Members* is the set of agents that belong to the group. These agents follow the definition presented in 3.1. The group *Structure* emerges from the members' relations and can be defined in different dimensions. According to Jesuino [11] these dimensions are: (1) the structure of communication; (2) the structure of power; and (3) the structure of interpersonal attraction. We have assumed that the structure of communication is simple (all agents communicate directly with each other) and, therefore, we will only focus on the group structure in two dimensions: the *structure of power* that emerges from the members' social influence relations, and the *sociometric structure* that emerges from the members' social attraction relations.

Furthermore, to define the group structure we must define the social relations among all the group members following these two definitions:

$$SocialInfluence(Source, Target, Value) \tag{3.3}$$
$$SocialAttraction(Source, Target, Value) \tag{3.4}$$

The social relations are directed from one agent, the *Source*, to another, the *Target*, and are assessed through a *Value* which can be positive, zero or negative. For example *SocialAttraction(A,B,50)* denotes that agent A has a positive social attraction for (e.g. likes) agent B.

In addition to the relations that agents build with each other, they also build a relation with every group they belong to. This relation captures the member's attitude towards the group and supports the notion of membership. Thus, for each group that an agent belongs to, we define one membership predicate according to the following definition:

$$Membership(Agent, Group, Motivation, Attraction, Position) \tag{3.5}$$

Agent and *Group* are the identifiers of the agent and the group respectively. The *Motivation* defines the level of engagement of the agent in the group's interactions and tasks. The *Attraction* assesses the level of attachment of the agent to the group. Agents with high levels of *Attraction* are very tied to the group while agents with low levels of *Attraction* are not very attached and, thus, can easily leave the group. The *Position* reflects the strength of the agent actions in the group, which depends on the social relations that the agent builds with the other members of the group and how skillful it is in the group. E.g. actions performed by agents that have more social influence over the others, or that the others like more, have stronger effects on the group. The group *Position* is computed using the following formula:

$$\begin{aligned} &\forall Group(G) \wedge A \in Members(G): \\ &Position(A,G) = SkillLevel(A,G) + \\ &\sum_{m \in Members(G)}^{m} SocAttraction(m,A) \\ &+ \sum_{m \in Members(G)}^{m} SocInfluence(A,m) \end{aligned} \tag{3.6}$$

3.3 The Interactions Level

In the interactions level, the model categorizes the possible interactions in the group and defines their dynamics. The term "interaction" is related to the execution of actions, that is, one interaction occurs when agents execute actions that can be perceived and evaluated by others. An interaction is defined in the model as:

$$Interaction(Type, Performers, Targets, Supporters, Strength) \tag{3.7}$$

Where *Type* defines the category of the interaction; *Performers* is the set of agents that were responsible for the occurrence of the interaction; *Targets* is the set of agents that are influenced by the interaction; *Supporters* is the set of agents that support the interaction (e.g agree with it) but are not directly involved in its occurrence; and *Strength* defines the importance of the interaction for the group. The *Strength* is directly related to the position that the *Performers* and *Supporters* have in the group, which means that the better the positions of these agents in the group are, the stronger the interaction effects will be.

3.3.1 The Classification of the Interactions

The classification of an interaction depends on the interpretation of the agent that is observing the interaction, which means that the classification process is dependent on the agent's knowledge and its perception of the world's events. E.g. the same action can be perceived as positive for the group by one agent but be negative in the view of another.

To support the classification of interactions we have defined a set of categories inspired by the studies performed by Bales [4] on his Interaction Process Analysis (IPA) system. Bales argued that members in a group have to simultaneously handle two different kinds of problems: those related to the group task and those related to the socio-emotional relations of its members. Based on this, in the model, the members' interactions are divided in two major categories: the *instrumental interactions* (related to the task) and the *socio-emotional interactions*. Furthermore, the interactions can be classified as positive if they convey positive reactions on the others, or negative, if they convey negative reactions.

Socio-emotional interactions fall into four categories:

1. **Agree [positive]:** this class of interactions show the support and agreement of one agent towards one of the interactions of another agent consequently raising the importance of that interaction in the group.

2. **Encourage [positive]:** this class of interactions represents one agent's efforts to encourage another agent and facilitate its social condition.

3. **Disagree [negative]:** this class of interactions shows disagreement of one agent towards one of the interactions of another agent, consequently decreasing the importance of that interaction in the group.

4. **Discourage [negative]:** this class of interactions represent one agent's hostility towards another agent and its efforts to discourage it.

In addition, we have defined four categories of instrumental interactions:

1. **Facilitate Problem:** this class of interactions represents the interactions of an agent that solves one of the problems of group problems or makes its resolution easier.

2. **Obstruct Problem:** this class of interactions represents the interactions of an agent that complicates one of the problems of the group or renders its resolution impossible.

3. **Gain Competence:** this class of interactions make an agent more capable of solving a problem. This includes, for example, the learning of new capabilities, or the acquisition of information and resources.

4. **Loose Competence:** this class of interactions makes an agent less capable of solving a problem. For example, by forgetting information or loosing the control of resources.

3.3.2 The Dynamics of the Interactions

Interactions create dynamics in the group. Such dynamics is modelled through a set of rules, supported by the theories of social power by French and Raven [9] and Heider's balance theory [10]. Such rules define, on one hand, how the agent's and the group's state influence the occurrence of each kind of interaction, and on the other hand, how the occurrence of each type of interaction influences the agent's and group's state.

In general, the frequency of the interactions depends on the agent's *motivation*, *group position* [13] and *personality* [1]. Thus, highly motivated agents engage in more interactions, as well as agents with a good group position or high extraversion. On the other hand, agents which are not motivated, with a low position in the group, or with low levels of extraversion will engage in few interactions or even not interact at all. These elements of the model are captured by the rule synthesized in the following equation[1]:

$$\begin{aligned} &\forall Group(G) \wedge Interaction(I) \wedge A \in Members(G) : \\ &\quad Extravert(A) \wedge GroupPosition(A,G) \wedge \\ &\quad Motivation(A,G) \vdash Starts(A,I,G) \end{aligned} \tag{3.8}$$

[1]The $\vdash$ denotes a relation of causality between the elements on the left and the right of the equation. In this case it expresses that the agent extraversion, group position, and motivation affect the probability of the agent to start an interaction in the group.

The agent's personality also defines some of the agent tendencies for the social emotional interactions [1]. Agents with high levels of *agreeableness* will engage more frequently in positive socio-emotional interactions while agents with low *agreeableness* will favour the negative socio-emotional interactions. This leads us to the second rule:

$$\begin{aligned} &\forall Group(G) \wedge SocEmotInt(I) \wedge A \in Members(G) : \\ &High(Agreeable(A)) \vdash Starts(A,I,G) \wedge Positive(I) \\ &Low(Agreeable(A)) \vdash Starts(A,I,G) \wedge Negative(I) \end{aligned} \tag{3.9}$$

The agent's skills influence the occurrence of the instrumental interactions, more skillful agents will engage in more instrumental interactions than non skillful agents [13]. This fact is expressed in the following rule:

$$\begin{aligned} &\forall Group(G) \wedge InstrInt(I) \wedge A \in Members(G) : \\ &\quad Skillful(A) \vdash Starts(A,I,G) \end{aligned} \tag{3.10}$$

Furthermore, agents with a higher *position* in the group are usually the targets of more positive socio-emotional interactions while the agents with a lower *position* are the targets of more negative socio-emotional interactions [13][2]. In addition, when an agent is considering to engage in a socio-emotional interaction, its social relations with the target are very important. Members with higher social influence on the agent and/or members for which the agent has a positive social attraction will be, more often, targets of positive socio-emotional interactions. Otherwise, they will be, more often, targets of negative socio-emotional interactions. The next two rules express these tendencies:

$$\begin{aligned} &\forall Group(G) \wedge SocEmotInt(I) \wedge A,B \in Members(G) : \\ &High(Position(B,G)) \wedge High(SocAttraction(A,B)) \wedge \\ &\quad High(SocInfluence(B,A)) \\ &\quad \vdash Starts(A,I,B,G) \wedge Positive(I) \end{aligned} \tag{3.11}$$

$$\begin{aligned} &Low(Position(B,G)) \wedge Low(SocAttraction(A,B)) \wedge \\ &\quad Low(SocInfluence(B,A)) \\ &\quad \vdash Starts(A,I,B,G) \wedge Negative(I) \end{aligned} \tag{3.12}$$

The group interactions also affect the group's state. For example, the *positive instrumental interactions* will increase its performers' *social influence* on the members of the group as well as its own *motivation*. Which means that any member that demonstrates expertise and solves one of the group's problems or obtains resources that are useful for its resolution will gain influence over the others [9]. On the other hand, members that obstruct the problem or loose competence will loose influence on the group and become less motivated. These rules are resumed as follows:

$$\begin{aligned} &\forall Group(G) \wedge InstrInt(I) \wedge A,B \in Members(G) : \\ &\quad Starts(A,I,B,G) \wedge Positive(I) \wedge \\ &\quad Motivation(A,G,m_1) \wedge SocInfluence(A,B,si_1) \\ &\quad \vdash Motivation(A,G,m_2 : (m_2 > m_1)) \wedge \\ &\quad SocInfluence(A,B,si_2 : (si_2 > si_1)) \end{aligned} \tag{3.13}$$

$$\begin{aligned} &Starts(A,I,B,G) \wedge Negative(I) \wedge \\ &\quad Motivation(A,G,m_1) \wedge SocInfluence(A,B,si_1) \\ &\quad \vdash Motivation(A,G,m_2 : (m_2 < m_1)) \wedge \\ &\quad SocInfluence(A,B,si_2 : (si_2 < si_1)) \end{aligned} \tag{3.14}$$

Socio-emotional interactions in turn are associated with changes in the *social attraction* relations. An agent changes its attraction for another agent positively if it is a target of positive socio-emotional interactions with that agent and

[2]Note that an agent has an high group position if it has high influence over the others and/or if the others have an high social attraction for it.

negatively otherwise. The encourage interaction has the additional effect of increasing the target's *motivation* in the group. The next equations resume these rules:

$$\forall Group(G) \wedge SocEmotInt(I) \wedge A, B \in Members(G):$$

$$Starts(A, I, B, G) \wedge Positive(I) \wedge$$
$$SocAttraction(B, A, sa_1)$$
$$\vdash SocAttraction(B, A, sa_2 : (sa_2 > sa_1)) \quad (3.15)$$

$$Starts(A, I, B, G) \wedge Negative(I) \wedge$$
$$SocAttraction(B, A, sa_1)$$
$$\vdash SocAttraction(B, A, sa_2 : (sa_2 < sa_1)) \quad (3.16)$$

$$Starts(A, I, B, G) \wedge Encourage(I) \wedge$$
$$Motivation(A, G, m_1)$$
$$\vdash Motivation(A, G, m_2 : (m_2 > m_1)) \quad (3.17)$$

$$Starts(A, I, B, G) \wedge Discourage(I) \wedge$$
$$Motivation(A, G, m_1)$$
$$\vdash Motivation(A, G, m_2 : (m_2 < m_1)) \quad (3.18)$$

Agents also react to socio-emotional interactions when they are not explicitly the targets of the interaction. Following Heider's balance theory [10], if an agent observes a positive socio-emotional interaction towards an agent that it feels positively attracted to, then its attraction for the performer of the interaction will increase. Similar reactions occur in the case of negative socio-emotional interactions. If in the latter example, the agent performs a negative socio-emotional interaction, then the observer's attraction for the performer will decrease. These rules are shown in the following equations:

$$\forall Group(G) \wedge SocEmotInt(I) \wedge A, B, C \in Members(G):$$

$$Starts(A, I, B, G) \wedge Positive(I) \wedge$$
$$SocAttraction(C, A, sa_1) \wedge High(SocAttraction(C, B))$$
$$\vdash SocAttraction(C, A, sa_2 : (sa_2 > sa_1)) \quad (3.19)$$

$$Starts(A, I, B, G) \wedge Negative(I) \wedge$$
$$SocAttraction(C, A, sa_1) \wedge High(SocAttraction(C, B))$$
$$\vdash SocAttraction(C, A, sa_2 : (sa_2 < sa_1)) \quad (3.20)$$

The intensity of the interactions' effects described on the previous rules directly depends in the strength of the interaction in the group. For example, encourage interactions performed by members with a better position in the group will increment more the target's motivation. In turn the strength of the interactions depends on the performers's and supporter's group position, thus, we can say that the group position is a key factor and the main driver for the dynamics of the group.

3.4 The Context Level

Finally, in the context level we define the environment where the agents perform and the nature of the group's tasks. The context defines the means that support the mechanism for the classification of the interactions according to the model (see section 3.3.1). Thus, two main definitions should be considered:

1. one related to the *task model* that supports the identification of the instrumental interactions. It defines, for example, whether a certain action is positive or negative for the resolution of the group task;

2. and another related to the *social norms* that support the identification of the social orientation of the group interactions. For example, social norms determine if a given action is interpreted as an encouragement or not.

Figure 2: The group of Alchemists is trying to activate one of the portals to move further in the planes.

4. A TEST CASE

In order to investigate the impact of the model in groups of synthetic characters, we have implemented it in the mind of autonomous agents that act as characters in a game called "Perfect Circle: the Quest for the Rainbow Pearl"[3]. The game takes the user into a fantasy world where the gods have been banned to imprisonment into the essence of gemstones, which have been shattered and scattered throughout the diverse world planes. The tales of the god's imprisonment are ancient and were completely unnoticed to men for many generations, until the finding of the sacred writings. Since then, several men, known as the Alchemists, have dedicated their lives to the study of gemstones and their secret powers. However, the writings are incomplete and reveal just a small part of the story. From time to time Alchemists organize in groups and depart searching throughout the world for further clues that may help to complete the missing parts of the story. In particular, Alchemists are looking for a special gem described in the writings as the perfect stone with the form of a multi-colour rainbow pearl. This stone merges the powers of all essences and the Alchemists believe that it may be the key to many of the gemstones' hidden secrets.

In the game, the user plays the role of an Alchemist that has joined a group of four other Alchemists to undertake the quest for the rainbow pearl. According to the writings the pearl is hidden in one of the elemental planes, which can only be reached through magic portals that are activated by the powers of the gemstones. The group is progressively challenged with the task of opening a portal (see figure 2). They need to gather and manipulate the gemstones together in order to get the required ones that will open the portal. Upon success, the group moves through the portal and is transported to the location of the next portal.

Members of the group have different skills and may en-

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

gage in socio-emotional interactions during the performance of the task. They can propose an action to gather, manipulate or use the gemstones; express their opinions about the others' proposals by agreeing or disagreeing with them; and can encourage or discourage the others.

5. EVALUATION

We have conducted an experiment with the Perfect Circle game, described in the previous section, in order to evaluate the effects of the SGD Model on users that interact with synthetic characters in the context of a group. Our goal was to test the hypothesis that groups of synthetic characters that interact following similar dynamics to human groups, will become more believable and consequently improve the user's interaction experience.

The experiment was conducted with 24 university students, 20 male and 4 female, using two main control conditions:

1. **Use of the SGD Model:** we built two different versions of the game: one where the characters followed the SGD Model and other where they did not. Thus, our first condition determines whether the subjects play with or without the believable group dynamics component.

2. **The Group Initial Structure:** subjects can start the game in a group with non neutral initial social relations of attraction or influence, which means that the initial group can have different levels of cohesion. Such levels may be very high or very low. We have considered two different scenarios: one where the group has neutral social relations and another where the members of the group dislike each other, which takes the group cohesion to very low levels. Note that this condition can only be applied when the game is run with the believable group dynamics component.

Following the work of Allen et al.[2], we have decided to measure the users' interaction experience by measuring their trust and identification with the group. Allen et al. have conducted an experiment to measure the satisfaction of the members of a group that performed their tasks through computer-mediated interactions. They argue that since, trust and identification have a strong connection with group satisfaction [8] [3], using their measures is a good approach to assess the group satisfaction.

Additionally they proposed two questionnaires: one to measure trust, with seven questions, and another to measure social identification, with five questions. We have adopted and slightly changed their questionnaires (removing one question for trust and adding one for identification), and used them to obtain our measures. We also added a free question to the end of our questionnaire where the subjects could write any desired comments.

During the experiment, we divided the subjects into three different groups with 8 elements each. Each group played the game with a different condition: the first group played the game without the SGD Model, the second one played with the SGD Model and with the group at neutral cohesion levels, and the third played with the SGD Model but with the group at low levels of cohesion. Subjects played the game for an hour and, afterwards, had half an hour to answer the questionnaire.

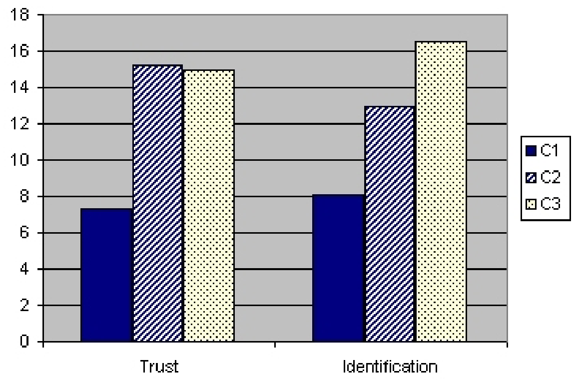

Figure 3: The questionnaire results.

We analyzed the questionnaires' results using the Kruskal-Wallis nonparametric test [4] which computed the results shown in figure 3.

The chart in figure 3 shows a comparison of the group trust and group identification measured on the three control conditions: without the SGD Model (C1), with neutral cohesion (C2) and with low cohesion (C3).

As one can see, there is a clear difference in the levels of trust and identification observed on the subjects that played with the SGD Model and those who played without the SGD Model. Trust and identification were higher when the synthetic characters followed a believable group dynamics. There are also some differences between the identification of the subjects with the group in condition C2 and condition C3. We believe this is due to the fact that, in the first case, the group socio-emotional interactions were mostly positive, what may be less believable than a group where the socio-emotional interactions are both positive and negative, as in the second case.

6. CONCLUSIONS

In this paper we have argued that group believability of synthetic characters is important when, within the group, we have characters and users interacting with each other. To achieve such group believability, we have proposed a model inspired by theories of group dynamics developed in human social psychological sciences, based on a categorization of the different types of interactions that may occur in a group. The model was implemented in the behaviour of several synthetic characters that collaborate with the user within the context of a computer game. This game was used on an evaluation experiment, which showed that the model had a positive effect on the users' trust and identification with the group.

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[4]We chose to use nonparametric methods to analyze the data because they perform better with small size statistical samples.

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