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Player-Specific Conflict Handling Ontology

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Abstract

This paper presents an ontology that provides the appropriate educational tools for a player of a serious game about conflict handling. The importance of this ontology lies in the fact that it promotes natural interaction (non-invasive methods) and at the same time makes the game as player-specific as it can be for its educational goal. It is an ontology that can be adapted to different educational theories and serve various educational purposes. In this ontology the Facial Expressiveness of a player at the moment of a game event leading to conflict as well as their Facial Expressive Response Amplification is used to determine the Intensity of the Emotional Stimulus. Once this is accomplished, the Player's Conflict Handling Model is taken into consideration in order to present the appropriate educational tool aiming to guide them towards an integrating way of dealing with conflicts in a social environment.

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Keywords: serious game; ontology; conflict; emotion analysis

1. Introduction

Concern about violence in schools has been increasing, and, correspondingly, conflict handling and resolution as well as peer mediation training programs have been proliferating [1]. Serious games are a very popular and useful tool in this process, i.e. games whose primary purpose is other than pure entertainment. According to [2], game-based learning/serious games are all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills. A conflict handling game creates an artificial social environment in which the children are presented with different options when it comes to dealing with a conflict. It is very important to bear in mind that conflict is not necessarily bad. This point has been very effectively made by developmental psychologists who work on

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children changing responses to conflict as they grow older [3]. This paper uses a game that encourages an integrating way of dealing with a conflict (Section 2.1). The relations between different concepts in the conflict handling and game playing domain, as well as the player's affective behavior, are represented in a multidisciplinary way, by an ontology. Researchers and developers in the fields of affective computing and conflict management/resolution will benefit from this, since it will offer access to relations and concepts from different sources.

Affective analysis of the player is used in the abovementioned game in order to detect their emotional state during conflict. Conflict provokes different reactions to the participants according to their character and expressiveness ("To recognize that we are in conflict is to acknowledge that we have been triggered emotionally" [4]). The digital game industry has lately realized an important shift to Natural Interaction (NI). The keyboard and the mouse are not necessary anymore, non-verbal behavioural cues are the new – natural – means of interaction. Research work in the fields of psychology and cognitive science related with non-verbal behaviour and communication stress out the importance of qualitative expressive characteristics of body motion, posture, gestures and, in general, human action during an interaction session [5], [6]. In the ontology presented in this paper, visual information is used, providing important cues about conflict progress and possible subsequent reactions of the player.

Within the context of computer and information sciences, an ontology defines a set of representational primitives that model a domain of knowledge or discourse [7]. According to Oberle [31], ontologies can be classified according to purpose, specificity and expressiveness, where purpose differentiates between application ontologies and reference ontologies mostly used for terminological reasons and specificity refers to generic, core and domain ontologies, with the latter being low on generality, but more specific and deeper in terms of describing a particular domain. Gruninger [32] describes the advantages of ontologies in three classes: Communication between systems, between humans, and between humans and systems; computational inference; reuse and organization of knowledge, with most developed ontologies being used to make domain assumptions explicit (70%) and enabling reuse of domain knowledge (56%) [33]. Compared to traditional approaches, ontologies provide two advantages in this framework: they help to semantically aggregate information defined in several separate descriptions and provide domain knowledge to non-experts to utilise and manipulate from their point of view. Thus, ontologies can capture a shared understanding of this domain and at the same time provide a formal and machine manipulable model for it. This is achieved by defining a vocabulary to describe the domain of interest. The constraints that describe the additional knowledge about the domain are also specified. Within this framework, ontologies are not only an efficient method for representing a domain, which in this case is the conflict handling game, but also a method for performing automated reasoning tasks to extract any required implicit knowledge.

In the ontology presented in this paper, the Facial Expressiveness of a player at the moment of a game event leading to conflict, as well as their Facial Expressive Response Amplification [16] is used to determine the Intensity of the Emotional Stimulus. Once this is accomplished, the Player's Conflict Handling Model is taken into consideration in order to present the appropriate educational tool or intervention aiming to guide them towards an integrating way of dealing with conflicts in a social environment. In terms of representing the conflict domain, this ontology maps visually manifested affective cues and emotional stimuli from the serious game to conflict handling styles and proposes interventions from the part of the game; as a result, it can be used by game developers to design and implement their own conflict management scenarios or design non-player characters that illustrate prototypical behavior and respond to specific events in the game environment. The ontology can also be extended to utilise information from player models or emerging information about the player (e.g. by questionnaires or interviews before playing the game) which can help define the player's status or conflict handling style before the game experience. Thus, adaptation of the game narrative or procedural generation [34] of conflict scenarios can be employed to present a truly personalized player experience and maximize the serious game's learning potential.

2. The Player

2.1. Conflict Handling Mode

In [8] the five modes of handling conflict on the basis of the attitudes of the manager - concern for production and for people - were presented. These modes were described as: forcing, withdrawing, smoothing, compromising and problem solving. This scheme was reinterpreted by [9] considering the intentions of a party in the following way: cooperativeness and assertiveness. The former describes attempts to satisfy the concerns of others, while the latter describes attempts to satisfy one's own concerns. The values of these dimensions combined describe the modes of behaviour: competition, collaboration, compromise, avoidance and accommodation [10]. The competition mode suggests that one party place their interests before those of another party, and thus adhere to their own solution in solving the conflict. The collaboration mode suggests that solutions that are optimal for both parties are adopted. The compromise mode is employed when solutions that are acceptable for both parties are adopted. The avoidance mode occurs when a party displays passive behaviour and shows no interest in conflict resolution. Finally, the accommodation mode occurs when one party allows the other to control the situation.
Rahim et al. in [11] and [12] differentiated the styles on two basic dimensions: *concern for self* and *concern for others*. The first dimension explains the degree (high or low) to which a person wants to satisfy the concern of others [13] (Fig. 1). For each of these styles, the interpretation in a game environment is mentioned.

- Dominating: high concern for self and low concern for others (win/lose).
- Avoiding: low concern for self and others. Removing themselves from the conflict, resulting in no solution (lose/lose).
- Obliging: low concern for self and high concern for others. Willing to let the other person have their way, giving in and giving up (lose/win).
- Compromising: intermediate in concern for self and others. It may be appropriate when the goals of the conflicting parties are mutually exclusive (lose/lose).
- Integrating: high concern for self and others. Awareness of both sides in a conflict, solving a conflict through working together. It is associated with problem solving which may lead to creative solutions (win/win).

2.2. Conflict Handling Models: Cultural aspects

The Face Negotiation Theory was proposed in [14] in order to understand how different cultures throughout the world respond to conflict. According to this theory, our self-image, or face, is at risk in conflict and our culture is attached to the way we deal with this issue and communicate. There are many different strategies and factors affecting how cultures manage identity ([15]). In [14] it is argued that in collectivist cultures, the face of the group is more important than any individual face in that group. In individualist cultures, the face of the individual is more important than the face of the group. People from collectivistic cultures usually adopt conflict styles of avoiding or integrating because the "mutual" face or the face of the group is the top concern. People from an individualistic culture adopt a conflict style of dominating because their main concern is maintaining self face because they have a "face" independent from that of the group. The Face Negotiation Theory is proposed as a useful tool in order to expand the ontology analysed in this paper. With further analysis, the theory could replace the conflict management questionnaire mentioned in IV, used to characterize the player, or enhance it.

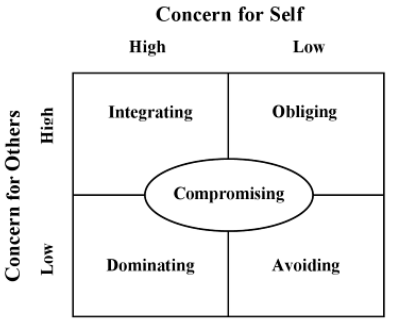

Fig. 1: Conflict Handling Models by Rahim M. A. [13]

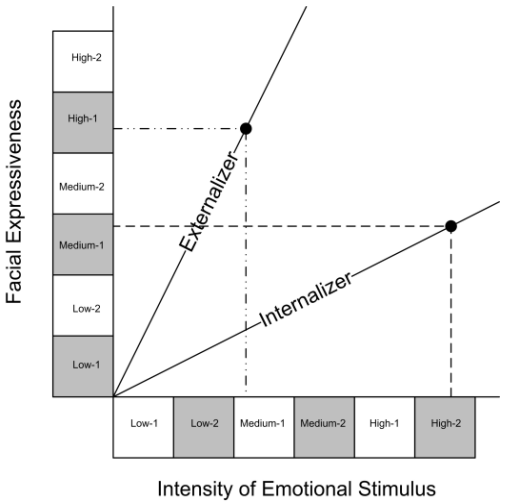

Fig. 2: Correlation of facial expressiveness and emotional stimulus

2.3. Facial Expressive Response Amplification

According to [16] all strong emotions result in some degree of activation of the organism (i.e., principle of stimulus dynamism) but there are individual differences in the gain operating on the facial expressive and sympathetic response channels of individuals. Focusing on the facial expressive response, the individuals can be categorized as *externalizers* when their somatic nervous system is characterised by high gain and as *internalizers* when it is characterised by low gain.

3. Facial Expression

Psychologists have examined a broader set of emotions, but very few of the studies provide results which can be exploited in computer graphics and machine vision fields. Many studies ([17] - [21]) suggest that one of the main characteristics of emotion is - among others – activation (also defined as arousal, expressiveness etc). This is the characteristic we analyze in this ontology. We specify how "expressive" (quantity of facial movement) the player is without defining the valence (positive or negative evaluation of the emotion). We could say that the player's emotional state is simply rated in terms of the associated activation level, i.e., the strength of the person's disposition to take some action rather than none. Facial analysis includes a number of processing steps which attempt to detect or track the face and to locate characteristic facial regions such as eyes, mouth and nose on it. The following step is to extract and follow the movement of facial features, such as characteristic points in these regions, or model facial gestures using anatomic information about the face [22], [23]. Although the Facial Animation Parameters (FAPs) provide all the necessary elements for MPEG-4 compatible animation, we cannot use them for the analysis of expressions from video scenes, due to the absence of a clear quantitative definition framework. In order to measure FAPs in real image sequences, we have to define a mapping between them and the movement of specific Facial Definition Parameters (FDPs), i.e. Feature Points (FPs), which correspond to salient points on the human face. A detailed description of the analysis procedure can be found in [24]. The measurement of FAPs requires the availability of a frame where the player's expression is found to be neutral. This frame will be called the neutral frame and is manually

selected or interactively provided to the system. For every facial feature (eyes, eyebrows, nose, mouth), a mask is extracted. The final feature masks are used to extract 19 FPs; FPs obtained from each frame are compared to FPs obtained from the neutral frame to estimate facial deformations and produce the FAPs. These deformations are used to define how expressive the player is, since large deformations characterize expressive players.

3.1. Facial Expressiveness and Emotional Stimulus

The facial expressiveness as a function of the intensity of an emotional stimulus for two individuals is described in [16]. As it can be seen in the graph of Fig. 2, which is based on [16], the function for the individual A who is characterized as an internalizer is different from the individual B who is considered to be an externalizer. It can be seen from this graph that the threshold on the axis of facial expressiveness over which an intense emotional stimulus is revealed for an internalizer is lower than the equivalent threshold for an externalizer.

4. Conceptual Model

In this ontology the Facial Expressiveness of a player at the moment of a game event leading to conflict as well as their Facial Expressive Response Amplification is used to determine the Intensity of the Emotional Stimulus. Once this is accomplished, the Player's Conflict Mode is taken into consideration in order to present the appropriate educational tool aiming to guide them towards an integrating way of dealing with conflicts in a social environment. The two general concepts of the Player's Conflict Mode and the Facial Expressive Response Amplification have been explained in Sections 2.1 and 2.3 respectively. This data is acquired from questionnaires that are given to the player prior to the game (Examples can be found in [25], [26]). Thus, the player's conflict handling mode will be characterized as dominating, avoiding, obliging, compromising or integrating whereas they will be characterized as externalizer or internalizer in regard to their facial expressive response amplification. The Facial Expressiveness of the player is derived from the video recording of them playing the game and being faced with a Game Event Leading to Conflict. Such a game event generates a conflict of interests between two players and occurs when the actions of one person attempting to reach his or her goals prevent, block or interfere with the actions of another person attempting to reach his or her goals [27]. The video is then processed by the facial analysis software in order to determine the levels of facial expressiveness.

The ontology takes into consideration whether the player is an externalizer or an internalizer in order to determine which of the two graphs in Fig. 2 characterizes the individual as well as the intensity of the facial expression. Through the graph mentioned above, the intensity of the emotional stimulus is determined (Fig. 4). The user of this ontology can determine the threshold over which the emotional stimulus is considered to be intense to a level which requires the appearance of the educational tools. In this paper the level "Medium–2" is considered to be this threshold. Note that, as described in Section 3.1, the threshold in the axis of facial expressiveness over which an intense emotional stimulus is revealed for an internalizer is lower than the equivalent threshold for an externalizer.

No action will be taken by the game in the following cases:

a) There is no intense emotional stimulus
b) The player's conflict mode is already Integrating

In all other cases the educational tools will be applied aiming towards an integrating resolution of the upcoming conflict. These tools will be adapted to the player i.e. they will be dictated by the player's conflict mode (Fig.5, Fig.6, Fig.7). The nature of these tools will be determined by the appropriate people. An educational tool can be, among others, a new game level, the introduction of a NPC (Non-Player Character) with a specific role, a pop-up window giving some advice etc.

The complete graph of the ontology can be seen in Fig.3.

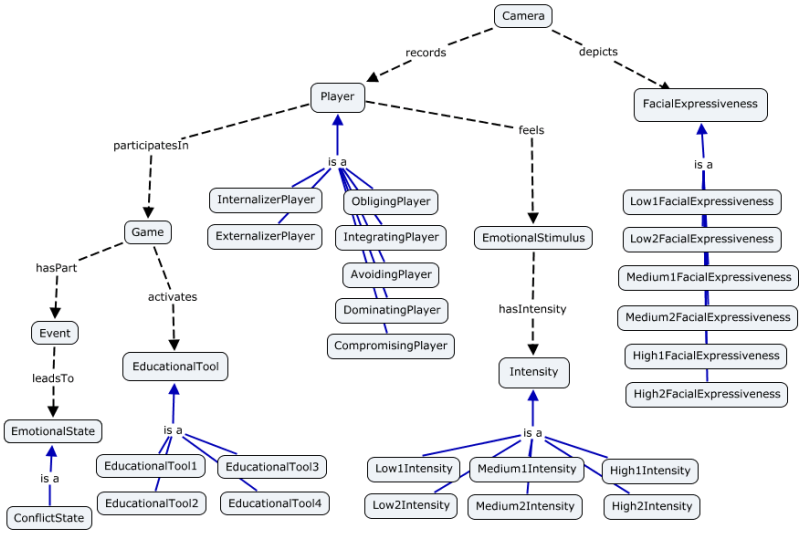

Fig. 3: Player Specific Conflict Handling Ontology

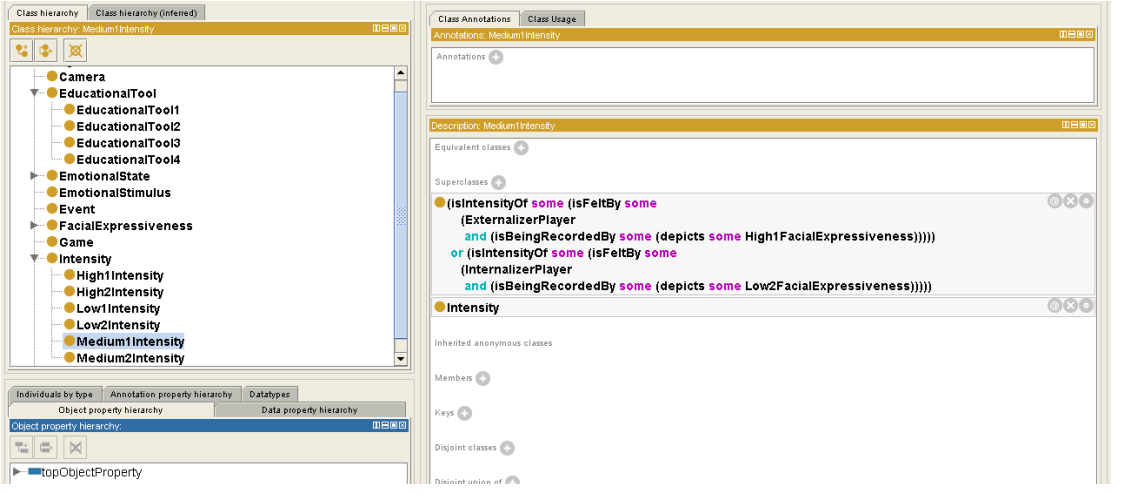

Fig. 4: Description of the concept Medium1Intensity

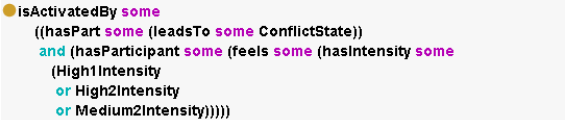

Fig. 5: Description of the concept EducationalTool

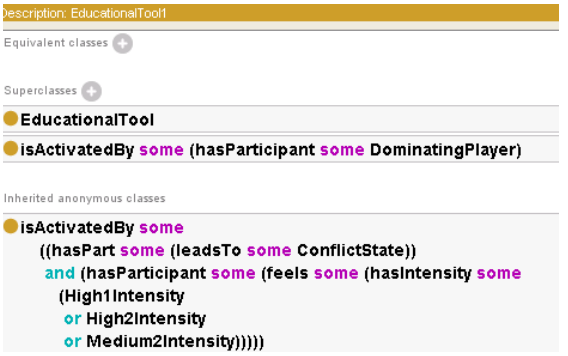

Fig. 6: Description of the concept EducationalTool1

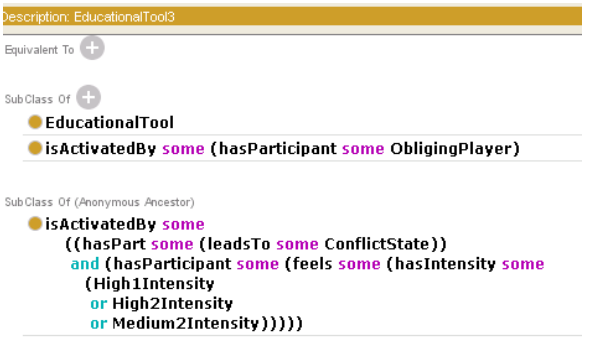

Fig. 7: Description of the concept EducationalTool3

5. The Ontology

In this work, the Player Specific Conflict Handling Ontology (PSCHO) is developed, based on the generic model described in the previous section along with the ontology engineering methodology – METHONTOLOGY– introduced in [28]. The objective is to develop an ontology flexible enough to be extended by future researches for their purposes.

For the formalization of the conceptual model described in the previous section the Web Ontology Language (OWL) was adopted. OWL is a language for producing web ontologies of high expressivity while, at the same time, is machine readable and enables extension from third parties. The ontology PSCH was built using the free, open source ontology editor Protégé [29].

The first step is to build the glossary of terms that identifies the set of terms to be included in the ontology. Our glossary contains the concept Player which constitutes a core concept of the ontology. According to the player's conflict modes, and since we regard these modes as unique and permanent characteristics of each player, we introduce the concepts AvoidingPlayer, ObligingPlayer, etc. For the same reasons the concepts ExternalizerPlayer and InternalizerPlayer are also introduced. As the player participates in a game it is necessary to introduce the concept Game to represent any game played by a player. The concept Camera is also used to represent the camera which records the player and depicts their facial expressiveness. The facial expressiveness and its levels as they are specified in Fig. 2 are represented respectively with the concepts FacialExpressiviness, Low1FacialExpressiviness, Low2FacialExpressiviness etc. Also, during the game the player feels an emotional stimulus which has a specific grade of intensity. Hence, the concepts EmotionalStimulus, Intensity and its respective levels Low1Intensity, Low2Intensity etc, are required to describe the domain of interest. As it was described in the previous section, the camera records the player while they are faced with a Game Event Leading to Conflict. Therefore, we assume that an Event which is part of a Game leads to an EmotionalState and at the same time a ConflictState is an EmotionalState. Finally the educational tools are represented with the concept EducationalTool and for the purposes of our ontology are categorized in four types: the EducationalTool1, EducationalTool2, EducationalTool3 and EducationalTool4.

According to METHONTOLOGY the second step towards the ontology development is to build concept taxonomies to define the concept hierarchy. The hierarchy is depicted in the graph of the Fig. 3 for brevity. The binary relationships between the concepts of the taxonomy are also depicted in the same graph. Although it could not be clearly depicted in the diagram, most of the relationships have a respective inverse one. For instance, the relation activates (domain: Game, range: EducationalTool) has an inverse relation defined as isActivatedBy whose domain is the EducationalTool and range the Game. The set of relations between the concepts of the ontology are demonstrated in the Table 1.

Table 1. Binary Relation Table of PSCH Ontology

Relation	Domain	Range	Inverse Relation
activates	Game	EducationalTool	isActivatedBy
depicts	Camera	FacialExpressiveness	isDepictedBy
feels	Player	EmotionalStimulus	isFeltBy
hasIntensity	EmotionalStimulus	Intensity	isIntensityOf
hasPart	Game	Event	isPartOf
hasParticipant	Game	Player	isParticipantOf
leadsTo	Event	EmotionalState	-
records	Camera	Player	isRecordedBy

The ontology is completed with a set of terminological axioms that capture additional knowledge about the domain. In particular, new axioms are required to define the various levels of intensity: Low1Intensity, Low2Intensity etc, based on the plot of Fig. 2. For instance, as it is demonstrated in Fig. 4, the concept Medium1Intensity can be defined as: a) the intensityOf some emotional stimulus that isFeltBy some ExternalizerPlayer who is being recorded by some camera that depicts High1FacialExpressiveness, or b) the intensityOf some emotional stimulus that isFeltBy some Internalizer- Player who is being recorded by some camera that depicts Low21FacialExpressiveness. Hence, if there is an internalizer or externalizer player for whom the camera records respectively Low-2 or High-1 Facial Expressiveness, then the intensity of the emotional stimulus will be defined as Medium- 2. The rest of the levels of intensity are defined in a similar way.

For the purpose of our study it is also necessary to describe every educational tool that appears in the ontology. As it was described in the section of the conceptual model, when the intensity of emotional stimulus exceeds a particular threshold an educational tool is activated. In this ontology we assume that this threshold is any value that belongs to the range of Medium-2 of intensity. Hence, we introduce a new axiom that describes the concept EducationalTool. This axiom is formally demonstrated in Fig. 5 and expresses that the EducationalTool isActivatedBy some game that hasPart an event that leadsTo some ConflictState and hasParticipant some player that feels some emotional stimulus that hasIntensity any of: Medium2Intensity, High1Intensity or High2Intensity. Each one of the four educational tools is activated according to the conflict mode that describes the player. For instance, as it is shown in Fig. 6, if the participant is a DominatingPlayer then EducationalTool1 is activated. Furthermore, as it is shown in Fig. 7 if the participant is ObligatoryPlayer then EducationalTool3 is activated.

6. Case Study

In this section a case study is presented in order to show the process of applying the Player-Specific Conflict Handling Ontology in a real-life situation. The terms used below that are also part of the ontology are accompanied by the relevant section in which they are explained and to which the reader can go back if needed. It is important to mention that the ontology provides a structure with solid rules that will ensure the outcome that we need. Having said that, each individual component such as the questionnaires used, the facial analysis software, the educational game etc, can differ according to the user's needs. The same applies for establishing thresholds.

Andrew is a 12-year old boy that has been having problems at school such as being alienated by the other students and ending up being on his own quite often. More specifically all disagreements with other students end up with him alone in the school yard. After observing this for a few weeks, his teacher gives him two

questionnaires to answer. The Berkeley Expressivity Questionnaire, proposed by Gross J.J. and John O.P,. gives Andrew a score of 2 in terms of expressivity (on a scale of 1 to 7). With this score he is characterized as "Internalizer" in terms of Facial Expressive Response Amplification (Section 2.3). The Conflict Management Styles Quiz, developed by Reginald Adkins, characterizes the student as having an avoiding style in Conflict Handling (Section 2.1).

The student is now going to have a month of educational game-playing sessions in order to learn how to deal with potential conflicts in an integrating way (Section 2.1). The computer game has a series of Events Leading to Conflict (Section 4). During these events Andrew's facial features are analyzed by a Facial Analysis software developed by [30] and the degree of his Facial Expressiveness (Section 3) is measured. This measurement is the equivalent of Medium-1 as it is depicted in Fig.2. Because Andrew is an Internalizer, the graph of Fig. 2 reveals that the Intensity of the Emotional Stimulus (Section 3.1) that he is experiencing at that moment is at the level of High-2.

The designer of the specific game has determined that the threshold over which the Intensity of the Stimulus is considered to be too high is Medium-2. Any measurement over this threshold is an alert for the game to take an action. This action is that Andrew will now find himself in a new level where he will be part of a team of NPCs. He will have the chance to observe the avoiding NPC being alienated from the group activities and the integrating NPCs working together towards solving the conflicts with the opposite team. Finally he will be asked to follow the example of the integrating NPCs and enjoy the results!

7. Conclusion – Future Work

In this paper the ability of ontologies to perform automated reasoning tasks to extract any required implicit knowledge, was used in order to create a serious game for conflict handling that implements player-adapted educational tools. The ontology presented allows for the users to implement the educational tools they think are more appropriate and helpful according to the players, the environment in which the game is played and the game itself.

Further work can be done towards multimodality, adding more inputs to the analysis software. These could be the player's voice or gestures, since the technology is already being used in commercial tools such as Microsoft Kinect, Nintendo Wii etc. Another input could be the biological signals which would add more accuracy to the detection of the stimulus' intensity. This is even more feasible nowadays, while maintaining the natural interaction aspect of the ontology as much as possible, since non intrusive, wireless EEG, HR, BP, SC sensors are widely available.

Acknowledgement

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