The Mind Module—Using an Affect and Personality Computational Model as a Game-Play Element

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Abstract—This paper describes the Mind Module (MM) which can be used in game worlds to assign avatars and autonomous characters personality traits, emotions, emotional attachments and moods which together form finely granulated states which are especially appropriate in systems where individualized play experiences are desired. The MM is implemented as a spreading activation network where the different nodes represent affective properties and has been used in several experimental game prototypes. In this paper, results are reported from play-tests where representations of affective processes were used as game-play elements. The MM API can be used with the particular nodes described in this paper or extended for use with nodes appropriate to other applications.

Index Terms—Games, intelligent agents, cognitive simulation, semantic networks

1 Introduction

Virtual game worlds (VGWs) such as the graphic massively multiplayer online role playing games (MMORPGs) or the text based multi user Dungeons (MUDs) are persistent virtual game worlds where players act via their player characters or avatars. There are a few striking aspects about VGWs that make them unique and different from other forms of art and one of these aspects is how the openness of the story structure, inherent in VGWs, enables players to add their own goals, resulting in additional narrative potential in the world. Another aspect concerns characterization, the core of good story telling. In VGWs players characterize their own avatars, comparable to how literary authors see their characters 'come to life', driving the story in new directions; in VGWs the situation is similar, but the stories are driven by *real* people rather than authored characters. In this aspect, VGWs are similar to table top role playing games where a game master together with a small group of players enact a game and its story while playing or acting as their avatars. However, Bartle stated in [6], VGWs are not narratives, instead they are places where narratives may exist. A central driving factor for play in VGWs is development of players' avatars which become, in Bartle's words, 'an extension of a player's self, a whole personality that the player dons when they enter the virtual world' (p. 155). From this perspective, there appear to be opportunities, to create alternative models for avatars that players can use for characterization and vehicles for play from a game design perspective. For instance, notions of personality and emotion taken from psychology might lend themselves to be used in an artistic way, as part of a game design.

The central question explored in this work is how representations of affective processes can be used in VGWs as game-play elements, such that players are able to create mental models of the game-play derived from these affective processes. Furthermore, the affective processes model should be lightweight and easy to configure and create, allowing game designers to easily create highly individualized game play experiences.

In order to explore this, an agent architecture, the mind module (MM), was built using established concepts of human affect. The MM models an agent's or avatar's personality as a collection of traits, maintains a dynamic emotional state as a function of interactions with objects in the environment and summarizes the current emotional state in terms of 'mood'. The MM is implemented as a spreading activation network (SAN) which is a suitable architecture for providing dynamic and fine grained states of mind.

The complexity of experimental applications for intelligent virtual agents (IVAs) together with the complexity of a virtual game world makes the task of integration daunting and there also exists the challenge of having a useful IVA from a game design perspective and ensuring that the IVAs can interpret objects in the world. This complexity is probably one reason why few IVA solutions are being used in games. One of the most challenging tasks in this work was to design and build experimental prototypes in which the MM was used. These prototypes were necessary to determine how the MM could be used in a game design and its effect on the game play experience.

The nodes in the MM SAN mimic different types of affects according to Moffat's [53] model where types of affect differ depending on how long they are active and whether they are directed towards something or not. Using a SAN together with these few principles allows for a very versatile system that is still simple to use and inexpensive in terms of processing power. It is possible to have an MM

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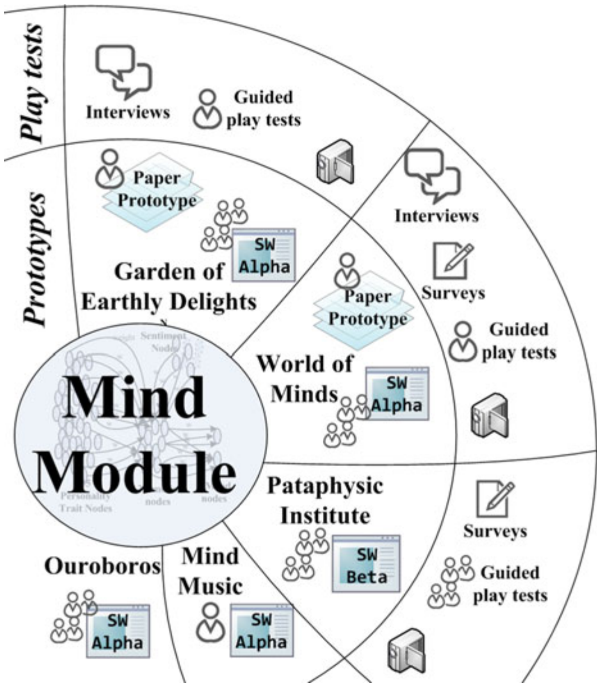

Fig. 1. Summary of prototypes the MM has been part of, how technically realized they were, and type of play-testing (if any).

generate many differentiated states with relatively few input sources from the world it acts within and this makes it useful for game worlds where highly individualized game play experiences are desirable. The very simplicity and the lightness make the task of making a world interpretable for the MM easier.

The MM has to date been used in five experimental prototypes (see Fig. 1). In the first prototype, *Ouroboros*, the focus was to explore the use of expressive gestures of 3D characters [77] where different gestures were available depending on the state of mind of the avatars and whether they were consistent with their personalities. *Garden of Earthly Delights* (GED) demonstrated the work package massively multiplayer reaching out (MMRO) of the integrated project for pervasive gaming (IPeRG). The focus of MMRO was to explore ways to integrate massively multiplayer gaming with the play via cell phones with geographical location data. A guided paper prototype play-test was conducted where issues of player-control of the semiautonomous avatar were discussed and showed that players with live-action role-playing experience were particularly positive towards the MM derived game-play in the test [40].

The *Mind Music* application focused on the use of music to express complex states of mind to players, communicating mood and emotions of their own avatar [24]. *World of Minds* (WoM) was implemented as a text-based game world. While the Ouroboros prototype focused on expression of character performed to other players through gestures, and the Mind Music prototype explored expression of their own avatar to players themselves through music, the focus of WoM was on expression of *character* to both self and others' in a multiplayer environment. McKee defined 'true character' as a characters' essential nature, expressed by the choices it makes, but character is also expressed by continuous observable behavior [50]. The text-based interface of WoM was too limited to represent the mental state of the MM to players and the implementation was reiterated completely as a graphical game world called the *Pataphysic Institute* (PI). In PI, character was expressed (to both the player controlling the avatar and the other players) through their actions—available actions changed depending on their personalities and mental states and strong emotions that characters 'felt' triggered the birth of autonomous creatures that cast spells propagating those very emotions to others in the world.

One of the important questions considered for all prototypes using the MM was whether players would be able to create mental models of the game-play derived from the MM, i.e., would they be able to relate to the concepts of different affective processes in a way that allowed them to play a game using representations of those as part of the game mechanics? This paper is structured as follows, first related work is described followed by a description of the MM where the sections are ordered according to the central elements of the MM node types: personality traits, emotions, moods and sentiments. This is followed by a section detailing the evaluation of the MM according to the players relationship to these elements, describing results from the two most elaborate play-tests done with games using the MM.[1] The first play test was conducted with the WoM prototype where many test scenarios were focused on evaluating the central elements of the MM while the second play-test is with the PI prototype where the scenarios were more focused on game play features that used the elements in combination, employing a design informed by the previous tests using those elements of affective processes that proved to be most intuitive to players and evaluating them again. The work presented here has been partly described elsewhere [24], but this is the first paper where the MM is the main topic.

2 Related Work

The work with the MM is related to many fields of study and since it is intended to be used as part of an autonomous or a semi-autonomous agent it is related to work in artificial intelligence (AI) where one of the aims is to create believable agents. This in turn extends the field to the tradition of building synthetic humans and theories from psychology, such as affect theory, trait theory and emotion modelling. However since MM is intended to be used in VGWs, the work is also related to narrative theory and game design.

When Bates [7] and his colleagues in the early 1990s coined the expression *believable agents*, the idea took a stance in the arts, generally in literature, theatre, film and radio drama, but especially in character animation for Disney characters. Bates described the agents as 'an interactive analog of believable characters discussed in the Arts' and argued that artists hold similar goals to AI researchers, wanting to create seemingly living creatures where the illusion of life permits the audience's suspension of disbelief. He argued that *emotion* is one of the primary means to achieve believability. The area of believable agents has

1. Several play tests were conducted in an iterative manner, however due to limitations in length of paper, not all can be described.

mostly been approached by making applications that, to varying degrees, create believability by using graphics showing facial expressions and gestures and by using language, spoken dialogue and dialogue in text, notably within the OZ Project [8] and the NICE project [56], and in works such as [31], [39], [42], [44], [46], [62], [64].

In the early 2000s Mateas described the field 'expressive AI' as an area that might provide a language for talking about 'readable' behavior in the context of game analysis and design, i.e., behavior that a player can 'read meaning into' [48]. As an example, Mateas discussed the *characterization* of the ghosts in the game Pac Man, expanding the discussion of characterization of non-player characters (NPCs) to encompass dynamic entities which do not have a humanoid form.

2.1 Narrative—Worlds and Characters

Approaches to *narrative* in games and computational environments are largely governed by the subject area covered by the work. In the area of games, classification spaces have been offered and comparisons have presented differences and similarities to other media (e.g., analysis of interactive media from a cultural-studies perspective, including Aarseth [1], Murray [54], Juul [38], and Ryan [66]).

Publications by authors with backgrounds in screenwriting and film-making often refer to the Hero's Journey [14], [75], and to the restorative three-act structure of drama [19]. Texts published by game designers frequently refer to the Koster-Vogel Cube [41], while publications in more technical venues on the issue of narrative often refer to the previously mentioned Oz Project [8] and to the Façade Project [49]. Prominent traditions of narrative analysis include the structuralist perspective beginning with Propp's morphology of the folk tale [61] and Greimas' actant theory [32], as well as the tradition of hypertext theory [11], [43], i.e., systems for causal interactive relationships between story elements in multi-linear stories.

When looking at narratives in games the player is a key component in the discussion due to their impact on the story and discourse. The degree of players' impact varies depending on the game design and multi-player games introduce more layers, i.e., several players interacting with the environment and each other. In role playing games they also characterize themselves for the benefit of the other players, being actants in a story that players construct and experience together. Richard Bartle, co-constructor of the first text based virtual world, states that VGWs are places where stories can happen rather than being stories themselves therefore in VGWs, players make their own stories.

In analysis of rich and complex characters in novels and screenplays, scholars have argued for the usefulness of defining characters' personalities via *traits*. Chatman, for example, argues for a 'conception of character as a paradigm of traits', where a trait is a 'relatively stable or abiding personal quality', noting that in the course of a story, a trait of a character may unfold or change [17]. Complex trait descriptions make the difference between flat and round characters:

> [...] the behavior of the flat character is highly predictable. Round characters, on the contrary, possess a variety of traits, some of them conflicting or even contradictory [...] We remember them as real people.

In VGWs, characters can be either fictional (non player characters, NPCs) or real people acting through their avatars. In VGWs and computer role playing games, NPCs and avatars have similar characteristics and affordances, all being people or 'actants' in the game worlds. What if characteristics of Chatmans' 'real' person were used in game worlds? In psychology, a real person is described by various theories of personality that can roughly be categorized as trait theories, type theories, psychoanalytic theories, behaviorist theories, cognitive theories, humanistic theories and bio psychological theories. A popular theory in the field of interactive virtual agents (IVA) is trait theory, pioneered by Allport in the 1930s [2]. Trait theory mined English language dictionaries for all the adjectives that describe personality and personality tests were developed to rate people along traits distilled from these studies. The Five Factor Model (FFM) [16], [73] is now a standard personality trait model in psychology; the clustering of traits via factor analysis into five factors has been repeatedly empirically validated. The most prominent assessment test for the FFM is the NEO PI-R questionnaire, which uses 30 traits and examples of systems using the FFM for autonomous characters and conversational agents' include [21], [23], [45]. IVA's are often built to function in scenarios akin to real world situations, such as guiding in museums [69] or ordering food at restaurants [45]. As such, it is possible to assume that agents should have similar affordances as humans acting in the real world. In game worlds however, characters can have very different abilities and affordances, since the worlds are fictional and function differently, for example, according to a D&D rule-set [34].

A game design project investigating trait theory was conducted by Drachen (formerly named Tychsen) et al., [74] who used the game engine of NeverWinter Nights [10] to experiment with combining the FFM with a traditional D&D system [34]. Personality traits were not implemented as part of the computational system itself but integrated into the personalities of the characters of the players as part of their descriptions. Additionally, personality traits were activated via inter-character relationships and through the game story-lines. Drachen's study supports the idea that players' engagement in an avatar is important for enjoyment in a multiplayer computer role-playing game and that highly complex avatars are not necessarily a problem for players. In fact, players tended to use all the features of the avatar, despite the complexity.

2.2 Mind Modelling

Emotion modelling has emerged as a field of study during the past decades and Minsky's *Society of Mind* [52] and the theory presented by Ortony et al. in 1988, now often referred to as the OCC model [59], proved to be landmarks in this area. OCC is a purely theoretical psychological model, but several applications in the fields of AI and cognitive science have used it as an inspiration for frameworks for autonomous agents that simulate human emotion, such as [20] and other work in the area of virtual characters that use *both* the FFM and the OCC as conceptual frameworks include [23], [33], [39], [42].

Ortony et al. [59] presented 14 theories of basic emotion that all list *different* emotions as basic with each theory using different basis for selection. Some of these theories use the concept of having mixed states [60] or compounds [4] and one of the most common theories of basic emotion is that of Ekman [22].

According to Moffat [53] *emotions* can be regarded as brief and focused dispositions (i.e., directed at an object), while *sentiments* can be distinguished as a permanent and focused disposition. Similarly, *moods* can be regarded as a brief and global dispositions, while personality *traits* can be regarded as a permanent and global dispositions. Moffat clarifies with examples (p. 135-136):

> An example of an *emotion* might be feeling a gush of affection for someone; while loving someone would be a longer term emotion, or *sentiment*. One could be in a generous affectionate *mood* all day and if that mood lasts a lifetime, we call it *personality*.

The MM draws upon Moffat's model for its general architecture. Moffat's notion of *mood* corresponds to that of Frijda [29], who describes it as 'free-floating' and objectless. Oatley et al. [58] describe a similar model where mood time-wise is longer lasting than emotion. An early system explicitly using the concept of mood as part of an agent's simulated mind is that of Hayes-Roth's Improv Puppets system [35]. The WASABI system employs a three dimensional space of mood and emotion and was implemented both as a museum guide and as one player in a two player card game [9]. In evaluations, the museum guide was found to be more believable, or 'human' by users the more emotional reactions it showed.

The application closest to MM in terms of both functionality and application especially regarding how the concept of mood is handled, is the Dynemotion People Engine (DPE) developed by Online Alchemy. The DPE is developed for use in virtual worlds and supports characters with personality, emotions and a summarized state of mind comparable with the mood of the MM. The DPE is not primarily a research project and so is not documented in publicly available sources. However, in co-operation with Mr. Sellers at Online Alchemy, a comparison between the DPE and the MM was made [26]. Both systems utilize agent-based architectures for characters in multi-player games and use the FFM as a framework for the personality of the characters. In both systems, a character's mood depends on recent experiences as the concept is described by [29], [53], but in both systems, the mood is also modified by the character's personality. Additionally, DPE and MM have similar solutions for *displaying* mood: both use the concept of a color coded co-ordinate system where the mood fluctuates along two axes allowing a high granularity of what the 'mood' is, expanding beyond the binary notions of 'good' and 'bad' mood. The emotional system of the MM feeding into mood is inspired by affect theory [53], [72] while the DPE uses an original model based on an underlying Maslowian system [47].

Another application which uses a summarized state similar to mood is an agent structure developed by Guoliang et. al. [33]. This work includes a factor for an agent's mood, where mood is briefer than a trait but longer lasting than an emotion. In the game The Sims 2 [27] characters have a mood represented as a diamond over the head of the character, which changes in color depending on the mood which in this case is a state that summarizes how well a character's needs, such as 'hunger' or 'social' have been fulfilled.

Even though the practical implementation of the MM can hardly be said to be related to the work of literary theorists, the design of the solution is inspired by structuralist theory [13], [32]. The *sentiment* nodes of the mind module allow for creation of connections between objects so that an entity can 'remember' another entity and what emotion node was activated in a previous interaction. This was implemented in order to enable each entity with a mind module in a world to have their own emotional history, or story derived from its own experiences. The emotional memory would not be represented linearly, but rather according to the nodes weighting and activation within MM's and MM's relating to each other. Other work that explores dynamic creation of emotionally valenced connections between entities in dramatic settings is [20] and FearNot! that uses the emotion-driven architecture FAtiMA [5]. Brisson's and Paiva's [12] system I-Shadows also used affective characters through interactions inspired by improvisation theory to explore the natural conflict between participants' freedom of interaction and the system's control as the participants collaboratively develop a story. Another related project is Scheherazade [28] which models semantics such as states, events, characters and goals as timelines as it draws upon theoretical work on the morphology of the narrative. The system can detect thematic patterns in both the deep structure of the story as well as in the manner of the story's telling.

From the related work we realized that affective processes such as emotions, mood and personality are important concepts and so were modelled in the MM. Also research has shown that using a model with a large number of personality traits is understood by players and leads to more complex and interesting real life-like characters. Another important design consideration was to use all the 30 traits of the FFM. The majority of systems mentioned here used either only the five summarized factors, or they use a small number of traits, applicable to the domain or scenario agents are used in. The mentioned study by Drachen [74] supported the fact that players are able to incorporate a multitude of traits in the mental models of their avatars and virtual characters. A similar notion, that players welcome more complex, or nuanced character models, was indicated in an early focus test of the MM (described in detail in [40]). A model was presented to the players that had a smaller number of emotions, and that only used the five main factors of personality of the FFM. Underlying the design of the play-test was an assumption in the team that the full model might be too complex however despite the teams' expectations, players welcomed avatars with richer personalities but there was however a divide between players' opinion on the matter depending on play-experience. Players with extensive experience of live action role-playing were more positive to avatars with extensive amounts of properties than players lacking this experience.

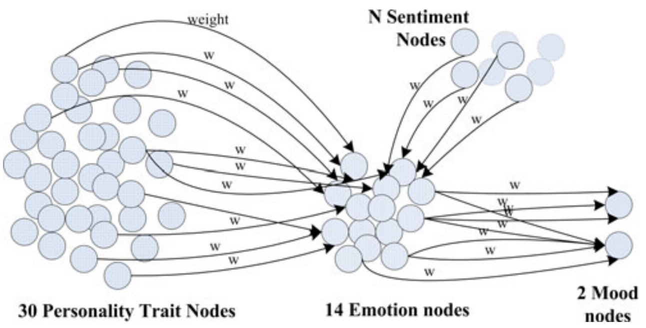

Fig. 2. Affect nodes in the Mind Module iteration used in PI.

Although these reviewed systems model some of these affective processes such as emotions, mood, etc., none of them try to use them as game-play elements, or are concerned with creating a lightweight model that can be used to simulate thousands of NPC's in a MMORPG.

The next section describes the Mind Module API detailing and motivating the choice of nodes according to design considerations that are written into the constructors of the open source version of the MM. During the iterative development of the MM various slightly different sets of nodes have been used. The version described here represents a selection of nodes which is general and have proved useful, but it is likely that each new application will need its own special modification therefore care has been taken to facilitate easy construction of different sets of nodes.

3 The Mind Module

The MM is implemented as a spreading activation network as defined and described by Quillian [63], Collins and Loftus [18], and Anderson [3]. The network consists of interconnected affect nodes where the traits, emotions, moods and sentiments described below are all different types of affect nodes that affect each other. When a particular node is activated, nearby nodes are activated as well and as one node is processed, activation spreads out along the paths of the network, but its effectiveness is decreased as it travels outwards.

This type of architecture is particularly appropriate for creating solutions for highly individualized game-play experiences and the combination space of potential states can be very large. In addition, a SAN is economic in processing because at any given time, only active nodes are instantiated in memory. SANs can be designed to have a high degree of context sensitivity and Anderson [3] concluded: '*Because activation can sum and varies with associative distance and strength, level of activation of a node is sensitive to the particular configuration of activation sources.*' Increasing the number and types of nodes that exist in a SAN, results in production of more finely grained states and the processing cost is controlled by reducing the number of nodes and careful setting of activation triggers and weightings between the nodes that control the number of nodes activated. Node selection also has an impact on the potential for very versatile behavior of SANs at runtime.

The choice of nodes and node types used in the Mind Module described here is the result of a balancing act where

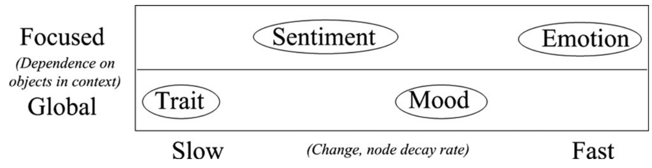

Fig. 3. The two-dimensional affect plane of the MM.

the number of nodes has been kept as small as possible while still being able to produce a fine granularity of potential states. The choice of nodes in the iteration of the MM described here is partly based on psychological theory grounded in empirical findings, and partly on design-considerations for the game prototypes it has been used in. In most prototypes, the activation sources for the nodes in the MM are gathered from the individual settings of a particular character's personality and from events perceived in the game world.

Given that there are numerous types of games it unlikely that only one set of nodes will be appropriate to all applications that simulate human affect. Use of the efficient SAN architecture together with node types that mimic the durations of different types of human affect for simulating the mental processes of a character is proposed in this paper. Work that has been done on certain sets of nodes is also reported and the API is available to anyone who wishes to experiment with these particular nodes or wishes to create entirely new sets of nodes.

3.1 Affect Nodes

The MM consists of a weighted network of interconnected nodes of four types: traits, emotions, sentiments and moods as shown in Fig. 2, all referred to as affect nodes.

The categories of affect nodes in the MM are inspired by Moffat's model, both in duration (persistence and briefness) and focus (whether the value of an affect node is dependent on another object in a context or not). Sentiments are not regarded as permanent in all cases, but certainly long lived in that their decay rate is slow compared to the quick emotions. The value of an affect node in the MM with a fast decay rate, such as an emotion, is non-zero for only a short period of time after a stimulus that causes the value of the node to change, and thus affects the value of other nodes in the network for only a short period of time. Hence emotion, mood, sentiment and personality can be seen as regions of a two-dimensional affect plane with focus (focused to global) along one dimension and duration (brief to permanent) along the other. The two-dimensional affect plane of the MM is illustrated in Fig. 3. The use of a two-dimensional affect plane while using a spreading activation network is suggested as a way of simulating affective processes for entities in games and the nature of the nodes should be adapted to the nature of the game the module is used in. The model can be used from both a bottom-up and top-down perspective and while the use of nodes that have different activity decay-rates is the basic (top-down) model, the selection of, nature of, and relationship between individual nodes can be based on a specific implementation setting or even real-time input data.

TABLE 1
Traits (Facets) Used in the Mind Module

Factor	Facet
Extraversion	Friendliness, Gregariousness, Assertiveness, Activity Level, Excitement-Seeking, Cheerfulness
Agreeableness	Trust, Morality, Altruism, Cooperation, Modesty, Sympathy
Conscientiousness	Self-Efficacy, Orderliness, Dutifulness, Achievement-Striving, Self-Discipline Cautiousness
Neuroticism	Anxiety, Anger, Depression, Self-Consciousness, Immoderation, Vulnerability
Openness	Imagination, Artistic Interests, Emotionality, Adventurousness, Intellect, Liberalism

3.2 Personality Trait Nodes

The MM assigns each character 30 trait nodes, inspired by the FFM, as shown in Table 1. The traits are grouped into five factors with the value of each factor being a weighted linear combination of the values of the traits. Each personality trait node of the MM API can be weighted towards one or several emotion nodes (See Table 3 as an example).

The weighting of the traits towards emotion determine how strongly a characters 'feels' an emotion depending on the personality. For example, a character with a high value of the trait anger could more easily respond with anger than a character with a low value.

Systematic information about the effects of personality on emotion from psychological research applicable for the MM is scarce. The weights set in the MM API are set in an experimental manner to resemble fluctuations in emotion according to personality, aiming for believability in potential role-playing settings, further expanded upon in Section 4. The nodes in the MM API are static however the decay-rates and weights can easily be modified to appropriate levels for a specific personality to emotion mapping, application, or game world. For instance if a game is played over long time, it would make sense to have dynamic trait nodes.

By adopting the FFM, the MM employs a trait-based personality and by choosing the model of personality as basis for constructing agents, one makes an implicit statement to the users of the systems about what a personality *is*. While extensive use of the FFM may result in an unfortunate uniformity, it is beneficial in that it is easier to compare the results of the work conducted in the field of virtual humans than if each researcher used a different theory of personality. The MM has a flexible design so that the traits of FFM can be replaced with another trait-based model as long as continuous variables are used.

3.3 Emotion

The open source MM API has 14 emotion nodes; amusement, interest/excitement, relief, joy, pride, surprise, satisfaction, fear, anger, shame, distress, sadness, guilt, and confusion. An emotion node is 'activated' if it has a positive value and can be activated by an event that calls the specific emotion. When called, the MM modifies the strength of the emotion according to the personality trait nodes that are connected to it. Once activated, the

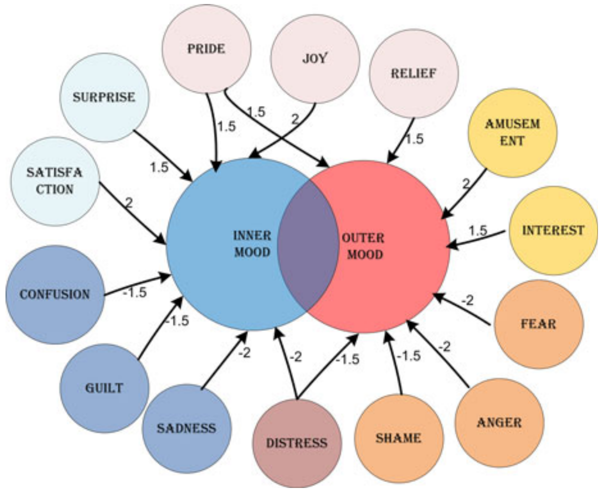

Fig. 4. MM API emotions nodes and their weightings relative to the mood nodes.

emotion node affects the mood nodes according to the weightings shown in Fig. 4. The weights are set to the values that proved believable to players in tests of the PI prototype and the sets of emotion nodes, as well as their weights to mood nodes, can easily be changed in the MM source code to suit other applications.

Choosing the set of emotions to use in the MM has been delicate task because research into basic emotions has shown that the emotions primates and humans *express* are not necessarily what they *feel*. Definite knowledge of how an individual 'really' feels might be beyond the capability of current research in general and information about the 'actual' feelings of a person is limited to active areas of the brain (visible in MRI scans, for example) and subjective narrative reports. However, the aim of the work with MM is not to simulate the *actual* workings of the human brain, but for use as a tool for the creation of interesting game-play experiences. It is the aim of believability that governs what parts to use from psychological research as inspiration for the building blocks of the MM.

The choice of emotions to use as emotion nodes in the MM is based on research into affects and affect theory by Tomkins [72], Ekman [22] and Nathansson [55]. The emotions specified by Ekman and others build upon studies of facial expressions. The emotions, (the so called 'basic emotions'), are not only similar across cultures, but also among primates and this was considered a benefit from a design perspective as it would imply that an avatar or an NPC without a humanlike graphical representation might still seem believable to players.

3.4 Mood

The mood of a person in real life is a complex state and is temporary and highly contextual but can linger even if the context changes. It is also individual, i.e., mood changes and fluctuations depend on an individual's personality and internal psychology, not just the context of the moment. In games, a summarized display of the state of mind of a character is useful both from authorial and user perspectives. In design, readily understanding a character's mood is useful for understanding the motivations and interactions of the character while from a user's point of view, a representation of mood is useful for viewing a concise display of the current state of mind that otherwise might be too complex to understand in a multi-tasking game-world environment.

The MM has two mood nodes—*only two* in order to facilitate a summary of how a character might feel, but *at least two* in order to display more nuance than just a scale of 'good' and 'bad'. The mood can be seen as 'the tip of the iceberg' of underlying emotions, i.e., a computed summary of the current state of mind of a character. The two mood nodes of the MM are designed according to Moffat's and Oatley's models where mood changes faster than personality, but typically more slowly than individual emotions as mentioned in Section 2. The duration of the effect of different emotion stirring events in the past on the current mood depends on the strength of the emotion and the decay rate and in the PI prototype, for example, an emotional event can affect the mood for between half an hour and several days, but typically it lingers for 1 or 2 hours.

The mood of a character is measured on two scales, an *inner* and an *outer* that are independent of each other. Each scale ranges from -50 to $+50$; corresponding to the range Depressed to Bliss and Angry to Exultant on the inner and outer scales respectively.[2]

The *inner mood* node represents the private sense of harmony that can be present even if the character is in an environment where events lead to a parallel mood of annoyance. Similarly, a character in a gloomy mood can still be in a cheerful mood space if events in the context give that result. The nature of the *outer mood* is social and tied to emotions that are typically directed towards and/or expressed towards another entity, such as anger or amusement. The two scales for mood nodes open up the possibility of more complex states of mind than a single binary axis of moods that cancel each other out.

Similar to the case with mapping between traits and emotion, there are few sources in psychology to guide the choice of weighting and since the purpose of the implementation was to facilitate game-play experiences rather than a true simulation of the human mind, this aspect of the MM was tested and reiterated accordingly (see Section 4).

3.5 Sentiment Nodes—Emotional Attachments

A sentiment node connects a game object or object type to an emotion, for example, a character with arachnophobia would have the emotion Fear associated with objects type Spider. If the MM of that character perceives a spider, there will be an immediate change in the value of the Fear node and the amount of change is a function of the strength of the sentiment as well as the values of the traits that modulate the value of Fear.

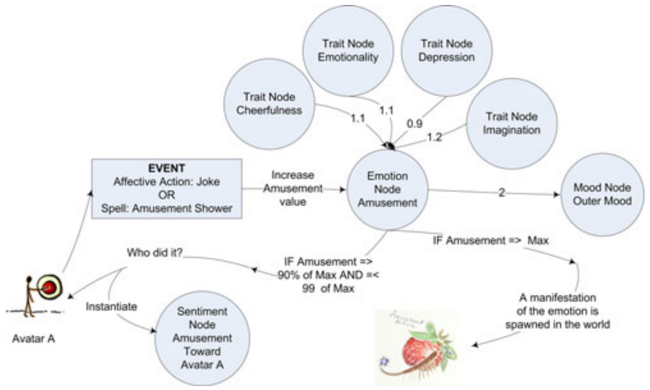

Fig. 5. An example of interpretation of an amusing action by the MM in the PI prototype.

The MM also allows several sentiments of different emotions to be directed towards another entity, for example, a character having a sentiment of Fear towards Spiders could also have a sentiment of Anger towards them. The intensity of the sentiment in the MM is different per avatar depending on the context since the intensity is defined by the context in form of sentiment objects in proximity and also via weightings between personality trait nodes and emotion. Thus the intensity of an emotion depends upon the avatar's personality, and the nature of the emotion is defined partly by events, objects and agents in the game world and partly by the individual avatar's interpretation of their environment in term of sentiments.

In a game world, sentiments can be created in two main ways. The *emergent sentiments* originate from interactions with other entities in the world creating emotional memories. In this case, if a threshold value is reached in an emotion node, a sentiment is created that connects the emotion to the object causing it and the threshold values operate on a percentage of a maximum value which can be set individually in the MM API. The *authored sentiment sets* have certain pre-set combinations, for example, infatuation is a combination of Interest/Excitement/Amusement and Joy towards another character.

One of the goals of the design of the MM was to allow agents to store emotional valences toward each other as emotional memories in such a simple and efficient manner that it would be possible to scale to large game worlds catering for thousands of objects interrelated by sentiment nodes.

3.6 An Example Event and Possible Consequences

There are two ways into the MM, to either send a value directly to one of the emotion nodes changing its current value, or to send an object into its 'perception'. In case the input is an object, the MM checks whether it has a record of it or its type, as being attached with a sentiment. If it is connected to a sentiment, the type of emotion and its value can be calculated as described above and changed in the corresponding emotion node. Every tic, the MM checks whether a significant change has occurred in any of the emotion nodes in order to calculate potential mood changes. Fig. 5 illustrates how an event in the PI

2. The reader perhaps associates with Russell's circumplex affect space [65] that represents polarities on several axes, similar to the mood scales of the MM model. Russell's circumplex affect space is a representation of humans' conceptualizations of emotional experience comprising two bipolar dimensions of perceived activation/deactivation and pleasure/displeasure. The MM and Russell's model should not be confused because in the MM model, the mood is an implementation-specific interpretation for games on how the emotions in the affect theory may be used in conjunction with the FFM, and functions along the lines of the research by Frijda [30] and Moffat [53], while Russell's affect space representation is a model constructed for understanding of the nature of human affect. Furthermore, the MM's and Russell's dimensions are different.

prototype, either a 'spell' or an 'affective action' (AA) causing amusement is interpreted by the MM where the values on the arrows between nodes are weights.

Suppose the PC A in Fig. 5 performs the AA Joke on PC B, and that B selects laugh as a reciprocal AA. (If a CM was the target of A, she could have chosen to cast the spell Amusement Shower.) The increase of the emotion node Amusement of B is calculated by the MM using the values of B's trait nodes Cheerfulness, Emotionality, Depression and Imagination. When the value of B's emotion node is calculated the value of B's outer mood node is updated. If the value of B's emotion node exceeds 90 percent of its maximum value, a sentiment of Amusement toward A is created. This means that when A is in proximity of B the value of B's emotion node Amusement will increase slightly. Metaphorically B senses an emotional memory of amusement.

If the value of B's emotion node exceeds the maximum value of the node a new entity is born, an Amusement article. The Amusement article casts the spell Amusement Shower on any avatar who happens to pass by. Metaphorically, B is so amused that he cannot keep the emotion to himself anymore, it 'goes out of bounds' and manifests in the VGW. When the Amusement article is born, B's emotion node Amusement is set to its mid value.

3.7 Limitations of the MM

An MM player character who again meets an entity that has made a strong emotional impression in the past will get a spike in the same emotion when perceiving the same entity again. A human player might remember the reason for it, while an NPC will have no means for this. Design-wise, in the WoM and PI prototypes, part of players' activities were to interpret their avatars' emotional reactions and to interpret reactions of NPCs that behave according to their sentiments. If a game design requires agents with knowledge about the past events this may be a limitation. In the design of PI it was, however, considered a sound compromise, allowing for a system that is relatively light in its need of system resources, but still allowing many simultaneous entities to be interrelated by emotional memories in a reactive manner. It should be noted that the MM is not intended to be used as the only means for creating a narrative in a VGW, but rather as a part of an overall drama management system also the MM does not supply the agent with beliefs, desires or motivations, but that it may very well be integrated with systems that do.

3.8 Systems Integration

The MM is written in C++ and has been made available for use with different prototypes for example, for use with the Mind Music it was made available as a DLL with the necessary functions exported. Input data, specific to this implementation, was read from XML files and the input data gave the MM the necessary information required for activation of the affect nodes. For use in the text-based world MUD, it was wrapped using SWIG so that functions could be called from a python-code base (or any other scripting language), while when used in PI it was added as library to the game engine code which is written by Mr. Pech at the game company Pixeltamer. The API and its documentation is available online.[3] In the MM's most encapsulated form, a system calling it would use four main functions: initialize, inform the initialized MM that a small amount of time has passed (tic), request the MM to modify the value of one of its emotion nodes and finally insert an object in its perception. In its least encapsulated form anything can be modified.

4 Evaluation

Experimental research and evaluations of rules and game mechanics in VGWs are rare in the academic sphere due to the enormous work effort required for the development of VGWs.[4] Researchers are generally constrained to studying existing VGWs or using existing systems (e.g., [15], [74]), such as the Aurora scripting system of NeverWinter Nights [10], that through their architecture enforces very traditional computer role playing game mechanics. When building new game mechanics from scratch where system support for a large number of simultaneous players is needed, it is necessary, unless the research funds are unlimited, to find alternative evaluation methods such as paper prototyping. In fact, it was a guided play-test of a paper prototype (of WoM), that gave initial results that players were able to relate to the different concepts of mental processes of the MM and use them in a systematic manner (described in detail in [24]).

The central question explored in this paper is how representations of affective processes can be used in VGWs as game-play elements, in such a way that players are able to create mental models of the game-play derived from these affective processes and in this section, the procedure of the play-tests are described followed by a recount of the results structured around the central affective elements; personality traits, emotions, moods and sentiments. In addition, a description is provided of how the central elements are used in the implementations of the prototypes. Due to limited space, results from the WoM play test are mainly reported here, since that test was designed to assess the four central elements of the MM. The design of the PI prototype was based on these results and focused on features that combined them. These design changes are reported next as well as the results from the PI test that may shed new light on the four central elements.

4.1 Game Play in WoM and PI Prototypes

In both the WoM and PI prototypes, players need to defeat physical manifestations of negative mental states. (See an example of one such creature in Fig. 7.) In order to do so, they can cast spells on them however the spells available are constrained by their avatars' moods. Through casting 'affective actions', players can affect moods of others and so change what spells can be cast.

4.2 Method, Procedure, and Participants of the WoM Play-Test

The most critical question in the play-test of WoM was whether players would be able to build mental models of the elements of the MM in order to use them in play. It was

3. https://sites.google.com/site/mindmodule/.
4. Rare, but not nonexistent, see, for example, [71].

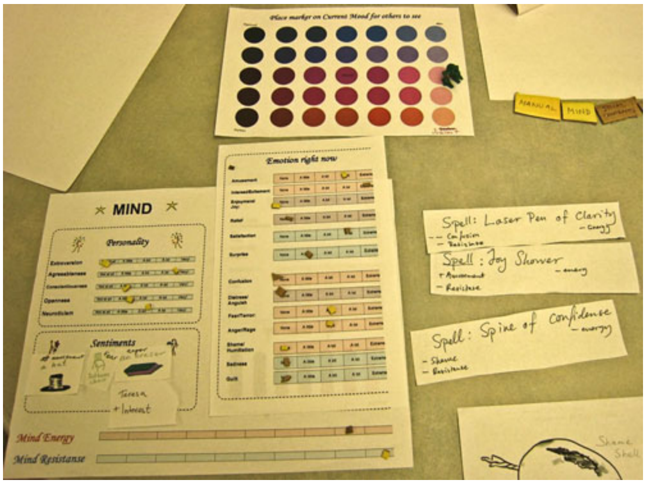

Fig. 6. Elements of the MM in the WoM paper prototype.

assumed that for any successful game design, players must be able to build a model of the mechanics that allow them to successfully interact with the game. Mental models here are defined as the result of the construction of meshed sets of patterns of actions as described by Schubert et al. [68].

A qualitative approach was used for play-testing WoM, inspired by methods from user-centered design as well as from iterative game design. Play-test sessions and interviews were videotaped and additional data was collected using web surveys. Data from the video-recorded material was gathered using the transcription and analysis tool Transana [76] and the data was analyzed using the model advocated by Miles and Huberman [51]. Results from web surveys were used for potential refutations of the findings and the activity-centered approach presented by Norman [57] was taken into account when design implications of the findings were considered.

A paper prototype of WoM was constructed in which players were guided through five scenarios that presented the main categories of action in WoM. Players were asked to think aloud while playing the game and in addition, the test leader stopped the game at two points and conducted interviews. During the five scenarios, each player was guided while using the main action categories in the game, including social actions that had an effect on characters' emotions ('affective actions'), navigation in a landscape of sentiment, and 'spells' affecting emotions and characters' energy and resistance.[5]

Using tokens in the paper prototype, the test leader updated the state of mind of the avatar and NPCs, showing the players the effect of their actions in the game in terms of fluctuations in emotions, mood, and mind energy and mind resistance. Fig. 6 displays the representation of these values in the paper prototype. Prior to the play-test, each participant had filled in a personality test which gave the values for the character trait nodes of the MM. Ten play-tests were conducted and participants had a mean age of 28 with a standard deviation of 5.6. Of the ten participants four were female and six male, all residents in California, USA.

5. Energy and resistance were used according to custom where characters have certain amounts of 'mana' for performing actions and 'health' for the amount of metaphorical damage they can sustain before 'dying'.

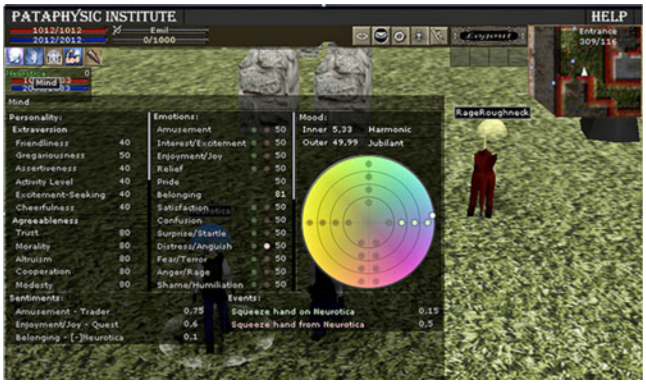

Fig. 7. Elements of the MM in the PI software prototype.

4.3 Method, Procedure, and Participants of the PI Play-Test

From a method perspective, the play-test of PI used a similar approach to that of WoM and Fig. 7 shows the screen where the window displaying values of the MM of a player's avatar is open. This was a multiplayer test where three players in each session were guided by a game master through three scenarios while the process was observed by the test-leader/designer. The test mainly focused on assessing the features of affective actions, sets of sentiments being set between players and players' authoring of autonomous entities that became the 'boss-mobs' to defeat in the last scenario (reported in [25]). Participants filled in two surveys, before and after play with the first survey focused on demographical data and expectations, while the second focused on the play experience. A total of 25 players with a mean age of 23.4 and standard deviation of 4.4 participated. Fifteen participants were male and 10 were female, all residents on Gotland in Sweden. The majority of the participants had experience of playing MMORPGs and nine sessions were conducted in total (illustrated in Fig. 8).

Each session took between 1 and 2 hours and the video materials gathered consisted of approximately of 20 hours of video capturing players and approximately 30 hours of video capturing avatars on screen using the software Camtasia [70]. The recordings also included a recording of players' faces captured by web cameras mounted on the screens and players' utterances were recorded via the headset each player was equipped with. The log-files of the play sessions were also part of the test data, one log for each player and session.

4.4 Traits and Emotions as Game Elements

The use of the FFM from a design perspective, allows for modelling an avatar after a players own personality—or at least as much as methods for assessing individual values of the FMM allow. It also allows for creating autonomous characters with distinct personalities or for players to create avatars to role-play that have personalities that are interesting from a role-playing perspective.

4.4.1 Traits and Emotions in the WoM Test

One of the interview questions was: 'How do you think the personality of your avatar affects the other values in the mind?' In response to this question, five players (50 percent)

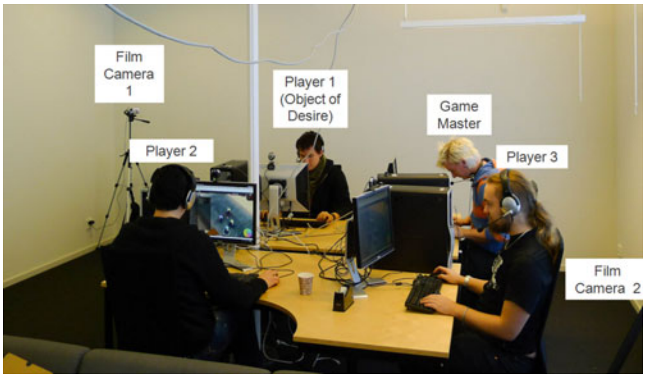

Fig. 8. Play-test of PI.

said personality affected the strength and/or nature of emotional responses. Two players (20 percent) thought that personality affected the amount of mind energy and mind resistance while three players (30 percent) thought that the effect of affective actions on themselves and others depended on personality. One player (10 percent) thought there were personality-specific effects on mood values, hypothesizing a mapping between traits, emotions and mood. All of these effects were indeed part of the mechanics.[6]

In the interviews and in the think aloud part of the test, it appeared that players had an inclination towards building models about Extraversion. Eight of the 10 players (80 percent) hypothesized about the Extraversion factor, though they had different hypotheses of exactly how the level of Extraversion would affect their avatar. Table 2 summarizes which personality factors participants discussed in the second question of the second interview. In the table, 'Relating' indicates the participant had a hypothesis about the effects of a particular factor, 'Mentioning' indicates the participant mentioned a personality factor but did not expand the discussion about a factor's potential effects, 'Unsure' indicates a participant attempted to build a hypothesis on the effect of a personality factor on other elements but did not form a conclusion.

One player hypothesized that *'Depending on how extroverted you are, sadness and guilt would probably move more or less as you are affected by them'*. Another player said *'So, like, if you are an extrovert you might get interested and excited more easily, but you also might get distressed or anguished more easily, so each one kind of ... you know ... had an effect on your emotions'*. Players chose to discuss certain emotions more than others in relation to Extraversion: amusement, anger, excitement and sadness were discussed by three players each, while the other eight emotions were only discussed by two players or fewer. Perhaps players found the emotions they discussed to be particularly relevant to extroversion.

The factor Agreeableness was interesting enough for six of the players (60 percent) to mention it and for three players (30 percent) to discuss it in more depth. The factor Conscientiousness was the most difficult for players to relate to.

6. Three of the players (30 percent) hypothesized about several effects, while the remaining seven (70 percent) focused on one effect that they described.

TABLE 2
Participants Hypothesizing about Personality Factors

Participant reasoning about personality factors	Participants n=(10)		
	Relating	Mentioning	Unsure
Neuroticism	2	2	0
Extraversion	8	2	0
Openness	2	2	2
Agreeableness	3	6	1
Conscientiousness	1	2	1

One player said: *'If you are not conscientious at all [...], other people pick up on that, how [...] are they going to ask you to do anything for them?'* These results indicate that players are able to successfully use their everyday theories of mind and personality to apply them to the personality-based game mechanics in WoM. However, design work may be needed to make some of the factors, such as conscientiousness, more understandable to players.

Participants were generally of the opinion that the personalities of their avatars had been reflected in a 'true' way by the results of the IPIP-NEO. This indicates that this method of character creation can yield personalities for avatars that correlate with the nature players intend for their avatars to have. The players also did not consider the issue of privacy of the personality trait values to be more important than the potentially interesting strategic elements that revelation of these values might result in. That is, if personality trait values of an avatar are visible to other players in certain contexts and this adds to the game-play experience, this is more important than the loss of privacy due to revelation of the avatar's personality traits.

Players with extensive knowledge of role-playing computer games however expressed reservations regarding the trait-based character system. This indicates that a trait-based system for characters can initially be difficult to understand for players who use mental models of traditional class-based character system of role-playing computer games in a

TABLE 3
Weights between Trait and Emotion Nodes in the PI Prototype MM Version

	emo_amusement	emo_interest_excitemen	emo_enjoyment_joy	emo_relief	emo_satisfaction	emo_confusion	emo_surprise_startle	emo_distress_anguish	emo_fear_terror	emo_anger_rage	emo_shame_humiliation	emo_sadness	emo_guilt	emo_desire**	emo_belonging	emo_pride
trait_extro_friendliness*																
trait_extro_gregariousness		1.1													1.3	
trait_extro_assertiveness										1.1						1.2
trait_extro_activity_level*																
trait_extro_excitement_seeking		1.1			0.8											
trait_extro_cheerfulness	1.1		1.1		1.1											
trait_agree_trust						1.1	1.1				1.1				1.1	
trait_agree_morality										1.1	1.2		1.1			
trait_agree_altruism			1.05									1.05				
trait_agree_cooperation		1.1													1.1	
trait_agree_modesty					1.2											0.9
trait_agree_sympathy		1.05			1.05					1.05		1.05	1.05			
trait_cons_self_efficacy					1.05								0.9			
trait_cons_orderliness		0.95				1.1								0.9		
trait_cons_dutifulness				1.1							1.1		1.1			
trait_cons_achievement_striving					0.8						1.1		1.1			
trait_cons_self_discipline				1.1	0.9									0.9		
trait_cons_cautiousness				1.1					1.1							
trait_neuro_anxiety						1.05			1.2		1.2	1.2	1.2			
trait_neuro_anger							1.05			1.3						
trait_neuro_depression	0.9	0.8	0.7		0.9		0.9	1.2	0.7	0.8		1.2				
trait_neuro_self_consciousness											1.3					0.8
trait_neuro_immoderation														1.2		
trait_neuro_vulnerability				1.05				1.3			1.1	1.2	1.1		0.8	
trait_open_imagination	1.2	1.2					0.9		1.05							
trait_open_artistic_interests		1.1			0.95											
trait_open_emotionality	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
trait_open_adventurousness		1.2							0.9		0.9			1.2		
trait_open_intellect		1.1					0.9		0.9							
trait_open_liberalism											0.9		0.9			

* no weight
**no weight from emo_desire to inner and outer mood.

context where a trait-based system is used. If the intended target group of a VGW using the MM includes avid computer role-playing game players this needs to be taken into account and the game-mechanics at odds with their preconceptions need to be communicated clearly.

Generally, the selection of emotions was accepted at face-value and did not render much discussion. In the WoM test, 13 emotions were used, all except Pride as specified in Fig. 4 which could be a result of the specific game design and the questions asked in the interviews and the surveys. This illustrates the fact that specific emotions as game play elements may very well be topics worthy of further study.

4.4.2 Design Notes about Extraversion

It is no surprise that the factor of extraversion was perceived as the most accessible, even in ancient Greek philosophy, extraversion is included as a central dimension of human personality. Research where the FFM is used in the context of synthetic humans and conversational agents also favors extraversion before the other factors [36], [45].

The participants in the WoM test expressed concerns about the performance of their avatars in social situations if their level of extraversion is low, relating to real world social situations where introverted persons have difficulties. If a game world heavily relies on game mechanics derived from metaphors of social interactions, such as affective actions, an introverted avatar can easily be perceived as 'gimped', i.e., the avatar has properties that make it difficult or impossible for its player to progress in the game.

A design goal of WoM was for personality traits to be non-normative: a game design in which each possible combination of personality traits allows a player to successfully progress in the game. In the play-test of WoM, the use of spells was very limited and only constrained by available mind energy. The feedback from the participants along with the non-normative design goal was used when refining the mind magic spell system for the PI prototype. In PI, the mood of a character determines what spells a character can cast and how strong the effect of them is. Neurotic and introverted characters are more inclined to become depressed compared with other characters so to balance cooperative play, the possible spells that could be cast by players in depressed moods were made more versatile.

4.4.3 Traits and Emotions in the PI Test

In PI, players filled in an IPIP Neo form in-game when they create their avatar. The code for the popular online 120 item version of the IPIP Neo was provided by Prof. Johnson [37] and was rewritten in C++ for use in PI. The weights between personality traits and emotions were set for characters in PI as indicated in Table 3. The selection of and number of emotions used in the MM differed in different iterations, governed by the design of the prototype the MM was used in. In the implementation of PI, three emotion nodes were added to those specified in Fig. 4: Desire, Belonging and Pride. The reason for adding Pride and Belonging was that PI to a higher degree than earlier prototypes used features inspired by social situations as part of the game-play mechanics. The emotion node Belonging is activated in PI in situations where several players co-operate while Pride is used in situations where players help each other especially when a more experienced player helps a new player. In such cases, the helping player may get positive emotions of 'Pride in another's achievement' when the player they are helping manage to do something successfully via their avatar.

Desire was added for use together with the emotion node Satisfaction which proved to be useful in PI in settings of social interactions where the game feature 'Affective Actions' is used. The affective actions allowed players to target each other and choose a social action such as 'hug', which had an effect on the values of the emotion nodes in the target. This can be regarded as beneficial in those situations, but has an effect that lack of satisfaction does not become a motivator for players to perform other actions where Satisfaction could be a reward for an accomplishment therefore, the emotion node Desire was added. This node was added to be used in the construction of story-driving sentiment objects, in other words, creations of 'objects of desire'.

During play-tests of the PI prototype, the weightings between trait and emotions nodes were changed considerably in order to create avatars whose emotions varied according to personality in ways that players thought more believable. The changes were made after each test session based on observations of play and on information given by players who had made the avatar-personalities to reflect themselves and who told the test-leader how their avatars 'should' react. In the PI play-test, the traits as such were not objects of scrutiny as separate objects. They only surfaced as separate objects when they did not function in a believable manner and in such instances they were changed to become better integrated into the overall game mechanics. An example is the weighting of the trait Emotionality which increases the strength of all emotions and one player had such a high value of emotionality that the game became difficult to play because his avatar's mood fluctuated so rapidly depending on the actions of other entities in the game towards him. He said it was as if he was on an 'emotional roller-coaster'.

Generally, the play-test of PI further confirmed that the use of the full FFM model is feasible for use in game design using affective elements (as suggested by previous studies as mentioned in Section 2). It was observed through the nine multiplayer sessions that in no instance did any of the 25 players find the model too complex or extensive.

4.5 Moods as Game Play Elements

In both the WoM and PI prototypes, the mood elements were central, both for communicating the general state of mind of a character and for determining what actions players' could perform through their avatars. For example, a happy character could not perform destructive actions and since the mood nodes were so central to specific game designs, the results of the play tests may generally be of more value to the actual designs than to mood as an affective process, but some observations, described here, are still noteworthy.

In the WoM test, the mood was represented by the position of a marker on colored mood board as shown in the top of Fig. 6. At the end of these test sessions, the mood of all 10 avatars was in the range between jubilant/exultant and bliss which indicates that the players had sufficient understanding of the system to act in such a way as to reach a desirable emotional state. These end-states indicate that players' preconceptions regarding mood states in their ordinary lives, where being in happy or harmonic moods are generally more desirable than in being furious or depressed moods, transferred to their choice of actions in the play-test. Being in a blissful or happy mood was perceived by players as a success criteria for their play. In the tightly scripted scenarios there was no indication given to players that this was *not* a desired state. However, in the WoM and PI prototypes, negative states of mind can be desirable in certain context even though this aspect of the game design was not tested in the paper prototype play-test. The behavior of the participants in the test indicates that if the game-play mechanics are at odds with the player's preconceptions regarding mood states in ordinary life this needs to be clearly communicated to players.

In the PI prototype, the mood was represented as dot in a coordinate system, where the dot's position signified the mood (see center of Fig. 7) corresponded to a color, which was displayed as a colored cloud around the character's head. Movement of the dot changed the spells that became available to players in the interface as clickable areas in the mood wheel. To the open ended survey question *How did the mood of your avatar affect what you could do when playing?* 84 percent (21) of the players, explicitly wrote that the mood affected what spells their avatars could cast. One player instead mentioned how the strength of their spells varied with mood, another mentioned how the amount of available energy for spell casting was affected and the remaining two merely noted that their mood had fluctuated. It appears that the notion that their avatars' moods would be tied to their affordances was a principle that came easy to players. The players made more differentiation of negative states of mind (depression, rage, fury, and anger) than the positive states that were plainly referred to as 'happiness'. In their answers to the open ended question described above 36 percent players mentioned happiness, 24 percent mentioned depression and 35 percent mentioned either rage, fury, or anger.

4.6 Sentiments as Game Play Elements

In the play-test of WoM, avatars were given sentiments in three different ways. First they received a random emotion assigned to a random type of object, then they had to choose one type of item to assign the emotion Fear to and finally they received sentiments as a result of interaction with an NPC named Teresa. On the game board, when players' avatars were moved close to objects they had a sentiment towards, the emotion it would represent would increase. For example, if a player had a sentiment of Joy towards Teresa, the value of the emotion node Joy would increase in her proximity. A scenario where players navigated among objects they had sentiments towards served to confirm that the concept of emotional attachments and their effect in a spatial environment was understandable. All players successfully navigated the board towards the goal and the majority of the players explored the effect all the different objects had on their avatar's state of mind, while a few committed to reach certain moods in order to experiment on the effect it would have in the coming scenario.

In another scenario, the NPC Teresa asked for help in defending herself against a foe representing the emotion Confusion. The players then used combinations of spells and affective actions according to the combat system in the prototype in order to help. The sentiments Teresa and the avatar had toward each other affected their states of mind, giving them different available actions because of these sentiments.

In a survey conducted after the test of WoM, players were asked to rate the three different types of sentiment objects according to their preference on a scale from Bad (1), Not so good (2), It was ok (3), Good (4), to Very good (5). There was a strong trend indicating preference for the sentiment objects that resulted from interactions with Teresa, which received the overall score of 4.58, while the sentiments given by limited choice were rated 4.0 and the random sentiment only 3.33. To the question of what sentiment object had made the most sense to the players and why, there was a strong trend towards Teresa (70 percent), with the reason that there was an effect to their actions that 'made sense'. Three of the players instead mentioned the chosen sentiments: *'because I picked it'*.

The interviews conducted in the play-test gave almost the same result as the surveys. Eighty percent of the players strongly expressed their approval for receiving a sentiment towards Teresa through interaction. One player said:

[...]even though it is a made up NPC, it is like just the way you are interacting, the way you are affecting her mood, it makes sense to have a lasting effect. Like I'm going to remember Teresa.

In the interviews, 50 percent explicitly expressed approval of the chosen sentiments and 30 percent of the random sentiments, a similar result as in the survey. In the think-aloud parts of the tests, most of the players were reasoning about each object's relevance to the rest of the context. The more impact they had had on the creation of the sentiment, the more meaning they could read into it. In the case of the sentiments towards Teresa they did not reason at all when they were 'thinking aloud'. Teresa and the sentiment towards her was not problematized or discussed, but accepted at face value and she was explored rather than questioned. The chosen and randomly assigned sentiments were on the other hand discussed and interpreted.

In the play-test of PI, the three players' avatars in each session were assigned sentiments toward each other. They were asked to picture a situation where two of them knew each other already and the third was new, and both 'old' players wanted the attention of the new, making this avatar an object of desire'. The two old avatars had negative emotions set toward each other and positive to the new avatar while the new avatar had positive sentiments to both the others. Pre-set sentiments such as these may be used for role-playing and as a means to drive potential stories. In this particular play-test however, which was more focused on aspects of co-creation and exploration of affect based combat mechanics, the sentiments were mostly used in a strategic manner, in order to manipulate the mood towards affordances needed in these contexts. In the survey, players were asked the open ended question *Did your avatar get sentiments towards other avatars? If so, which? How did they emerge?* Seven (28 percent) described the pre-authored sentiments, while five (20 percent) could describe the emergence of such during play. One player wrote: *My avatar got* *positive feelings about Nina but I didn't notice that much until Nina and Aslan went away together*. Unfortunately many (35 percent) of the answers showed that the respondents had misunderstood the question. This was probably due to the technical formulation ('sentiment' as a game play element) or another cause could be that sentiments were not central to the game play scenarios and thus only given attention by players if they had a noticeable effect on the play experience. Generally though, in both play tests, it was observed that players accepted the notion of sentiments, that is, that their avatars would have emotional connections to other entities in a game world, at face value, as something 'natural'.

5 Conclusions

This paper described the mind module, a spreading activation network whose node types represent affective processes in terms of duration and strength of activation as well as in weightings between nodes. The MM models characters as having traits according to the FFM: a set of emotions, sentiments as emotional connections between entities and moods as summarized states of mind. The MM has been used in several experimental game prototypes and it or modifications of it, may be particularly suited for use in virtual environments where individualized play experiences are desirable due to its versatility and ease of integration to other systems and architectures.

The central question explored in this paper was how representations of affective processes could be used in VGWs as game-play elements, in such a way that players are able to create mental models of the game-play derived from these affective processes. In this paper, results concerning how players relate to the four central elements of the MM were reported. The data was collected in evaluations of two game prototypes; WoM and PI where play-test participants used mental models of mood and personality from their ordinary lives to understand the MM-derived game mechanics when information given in the play-test did not contradict these models. Generally, the findings indicated that participants were able to formulate 'correct' mental models of the MM-derived game-play in that they constructed meshed sets of patterns of action potential that allowed them to act in a way that had the effects on their avatars that they desired. Further, the play-tests indicated that players could successfully build mental models of game mechanics mimicking affective processes as long as they did not clash with perceived genre specific game mechanics. The MM API provided is open source and contains a particular selection of nodes that, with their interconnections and weights, 'made sense' to players as game-play elements.

6 Future Work

Many would probably agree that at the heart of narrative arts is the protagonist's striving towards goals of different types where hindrances towards it are a basis for conflict. The depiction of conflict often takes up a large portion of the whole of the discourse of a dramatic work. This is also the case in computer games—players defeat foe after foe in game in order to get closer to goals and rewards. The concretization of conflict is usually done through representations of physical violence and types of conflicts such as quarrels between people who know each other well are seldom portrayed in digital games. These motives are confined to works in theatre, film and literature (with a few exceptions such as the interactive drama Facade [49]). There appears to be an untapped potential in creating drama in games and one way of approaching this design-space could be through systems that help designers integrate affective processes into game mechanics. This allows use of not only representations for, but also mechanics of, social praxis. Future design work involves further experimentation with affect based game mechanics as representations of conflict in games and as potential drivers for drama.

Future work regarding the MM API includes integration with EmotionML [67] to allow for time specifications that might be used for decay rate settings in an MM, as well as referencing between objects and emotions, which would be useful for sentiment node settings. Such integration might facilitate easier integration of agents into game worlds, so that environments can be made 'readable' to agents and avatars in affective terms.

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