Good Moods: Outlook, Affect and Mood in Dynemotion and the Mind Module

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Abstract

In this article we describe two systems for autonomous characters intended to simulate the minds of characters in virtual game worlds. These systems, the Dynemotion People Engine (DPE) and the Mind Module (MM), are here presented with special focus placed on the design and implementation of the parts of the architecture that simulate what is colloquially called mood. The mood feature is presented to the user in both applications as a fine-grained matrix that summarizes the character's state of mind, typically a complex state. Thus in both systems the mood feature functions as a qualitative guide describing the affordances for the interaction with one's own avatar or another character at a given moment. This simplifies the design and balancing of game design in terms of authorial affordances and provides a more familiar context for user-character interactions.

Author Keywords

Mood; personality; trait; character; multiplayer; affect.

Introduction

While trait theory from personality psychology and affect theory have been used as inspiration for systems that give agents emotions and personality, there is no obvious theory in the field of psychology or cognitive science to lean on when it comes to modeling what we in daily speech call mood. In this paper we use the word mood in this everyday sense, to mean an overall state or quality of feeling at a particular time. Mood changes faster than personality, but typically more slowly than individual emotions. The mood of a person in real life is a complex state. It is temporary and highly contextual, but can linger even if the context changes. It is also individual; the way mood changes and fluctuates depends on the individual's personality and internal psychology, not just the context of the moment.

This paper began to take shape when the authors of this paper met for the first time. When comparing our systems - the Dynemotion People Engine (DPE) and the Mind Module (MM), we found striking similarities though the systems had been developed without knowledge of each other. Both systems are agent-based architectures for characters in multi-player games, and use the Five Factor Model (FFM) as a framework for the personality of the characters. While the emotional system of the MM is inspired by affect theory (Tomkins, 1962) and the OCC model (Ortony, 1988) and the DPE uses an original model based on an underlying Maslovian system, neither of us had found applicable theories to draw upon for modeling the summarizing state of mood, but both saw the need for such a feature. A summarizing display of a character's state of mind is useful both from an authorial perspective and from a user's perspective. In design readily understanding a character's mood is useful for understanding character motivations and interactions. From a user's point of view a representation of mood is necessary to have an accessible concentrated display of the current state of mind that otherwise might be too complex to understand in a multi-tasking game-world environment.

In both DPE and MM mood is a state that can be seen as ``the tip of the iceberg" of underlying emotions. A character's mood depends on their personality and on what he or she has experienced in its current context. Additionally, DPE and MM have similar solutions for displaying mood: both use the concept of a color coded matrix where the mood fluctuates along two axes that allow a high granularity of what the "mood" is, expanding beyond the binary notions of "good" and "bad" mood.

In this paper we present Dynemotion and the Mind Module with a focus on the summarizing state of a character's mood. We compare these systems, present a small qualitative user study and discuss the systems from a technical and authorial point of view.

Related Work

In psychology, trait theory has been developed to describe real life personality. Trait theory, pioneered by Allport (1961) in the 1930s, is one of several major branches of theories of personality, where the other branches roughly can be categorized as type, psychoanalytic, behaviorist, cognitive, humanistic and biopsychological theories. From trait theory, several different personality assessment tests have been developed by psychologists, one of the most prominent being the Five Factor Model (FFM, also called "Big Five"), which can be assessed for individuals using a questionnaire called the NEO PI-R (McCrae, 1987).

Table 1 Traits in NEO PI-R (also called OCEAN)

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

Emotion modelling has emerged as a separate field of study during the past decades, where the theory presented by Ortony et al in 1988 proved to be an important landmark, now often referred to as the OCC model (Ortony, 1988). The OCC model is purely theoretical, written in the field of psychology, 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. Other work in the area of virtual characters that use both FFM and OCC as conceptual frameworks include works by Guoliang (2006), Klesen (2000), Kshirsagar (2002) and El Jed (2004). El Jed describes a virtual reality training environment tool for fire men. Guoliang's work include a factor for an agent's mood, where mood is briefer than a trait, but longer lasting than an emotion (this work also highlights the lack of unified definitions of mood in the literature). An excellent discussion of the field of virtual characters with personality, emotions and mood can be found in the State of The Art Report "Building Expression into Virtual Characters" by Vinayagamoorthy (2006). In contemporary games a few like The Sims 2 (2004) have a bearing on this topic, where the characters have a mood represented as a diamond over the head of the character, which changes in colour depending on the mood. The mood in this case is a state that summarises how well a character's needs, such as `hunger' or `social' have been fulfilled.

Dynemotion

The Dynemotion People Engine (DPE) is a system developed by Online Alchemy, Inc. for creating agent-based AIs embodied in a virtual world context. The DPE is intended for use in games and simulations for training, therapeutic, and other uses. The AI aspects of DPE characters can also be applied to the player's avatar in a virtual world, providing the player with additional information about and insight into their character and the world.

Basic Attributes

DPE characters have personalities, desires, goals, and emotions. They observe and learn from the world around them, they are able to exchange opinions and experiences, and their memories affect their later goals, actions, relationships and personality. DPE agents have a personality typically based on the Five Factor Model (FFM). This creates a long-term baseline for the character's associations with their environment. For example, a character with a high Neuroticism score would be more likely to experience greater anxiety given an observation of the same "fearful" object than would another character with a lower Neuroticism score. Personality in DPE characters is not immutable, but can change slowly over time based on their experiences.

At the heart of the DPE is a set of quasi-Maslovian motivational desires that act as largely independent sub-agents. The type and number of these desires is variable, but they typically follow the outline of Maslow's hierarchy of needs (1943) including physical, safety, social, skill, and "contribution" or self-actualization needs. Through observation of external conditions (including observed objects, people, and events with emotional associations) and internal states, and modified by the character's memories, associations, and personality, these desires determine the character's goals and action choices.

Emotions

Significantly, each of the desires enables the mapping of separate internally perceived emotional content. That is, each desire creates an emotional state-space, such that a character might feel hungry, hopeful, lonely, and proud all at the same time based on the states of different internal desires. In broadly defining 'emotion,' we follow an approach informed by the Schacter-Singer "two factor" theory (1962), including all cognitively apprehended aspects of physiological or qualitative psychological states and processes.

Some of these emotions appear and fade quickly, while others are much longer lasting (surprise vs. empathy, for example). This enables a much more nuanced and layered set of emotions that are tracked internally beyond just "happy" or "sad." For example, "happiness" can correspond to various combinations of pleasure, delight, amity, satisfaction, empathy, and joy (an incomplete set of inexact names for "happy" emotions moving up the Maslovian hierarchy from physical to peak experiences). These emotional distinctions are not taken from any existing model, but are derived from the applicable emotions for each desire. These distinctions are necessarily qualitative, but have met with comprehension and acceptance in early user tests.

Mood Display

While DPE characters, like humans, have a richly textured internal emotional landscape, it is not always possible (or desirable) to communicate the many layers of feeling at all times. When interacting with another person, a pinched look on their face may indicate a variety of conditions from indigestion to social rejection; we map a complex internal space to our faces, gestures, and speech. This mapping condenses many conditions into a smaller state space which in turn aids in fast comprehension of overall qualitative emotional state - what we typically call someone's mood. To aid in comprehension of one agent's emotional state, or mood, by another agent or by a human user, we map the internal layered model to a two-dimensional space that is also color-coded to provide a qualitative, locational visual indication of the overall mood. Internally each desire's emotional state maps to this mood space, but the mood is typically displayed as an aggregate of all internal emotions.

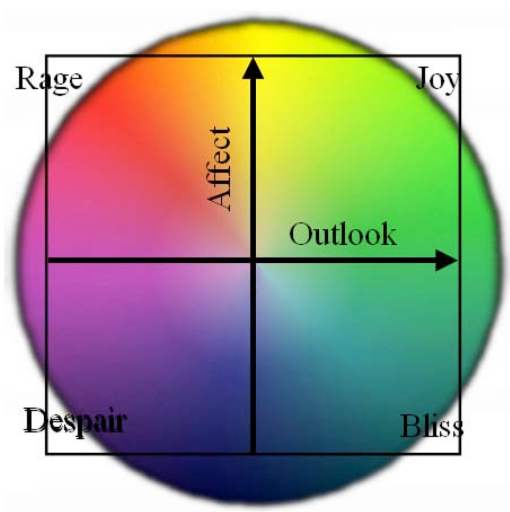

Figure 1 The Dynemotion Mood space and color

This mood mapping has two axes: the x-axis is termed "Outlook"; it is the overall positive or negative valence to how the individual is feeling - in broad terms from avoidance to attraction, unhappy to happy, or generally "bad" to "good." The y-axis is a depiction of expressed energy, and is thus called "Affect." In broad terms this varies from inert or insensate on the low end to very high-energy (surprised or excited) on the upper extreme.

Combining these two axes together yields the two-dimensional mood space shown in Figure 1. Normalizing the two axes so that each covers the range [-1,1], we can describe the four extremes and other important points. High Outlook, high Affect (1,1) is high-energy happiness; this corresponds to pleasurable or joyful moods, or other forms of active positive feeling. High Outlook, low Affect (1,-1) equates to satiation or a peaceful, zen-like calm. Low Outlook and low Affect (-1,-1) describes an unmotivated (low-energy) unhappiness, best exemplified by despair. Low Outlook, high Affect (-1,1) can be seen as rage. The primary difference between these two negative poles is that in the latter the individual is ready to act, to lash out, while in the former the lack of energy indicates that no action is deemed possible or relevant.

In between these points we have the ends of the axes: high Affect (wired/excited); high Outlook (pleased); low Affect (lethargic or insensate); and low Outlook (not merely unhappy but also encompassing extreme repulsion or fear reactions). The color mapping applied to this quadrant system is based on a typical color wheel, but with some adjustments: the color becomes more saturated as values diverge from the center ((0,0) is emotionally neutral and thus gray), and the colors become darker with decreasing Affect. This yields a bright red for anger, a light green for joy, a blue-green for peaceful calm, and a deep blue-violet for despair.

In our early user testing, these color combinations have been readily recognizable as shorthand for mood when displayed on or around avatars. A group of characters with a red glow or red disks at their feet are quickly seen as being an angry mob, for example. Given the qualitative nature of the colors, as a character's mood changes, corresponding changes in their displayed color value is an understandable indicator of their emotional shifts. We have also experimented with assigning text-string indicators to different locations in this quadrant space (up to 64 separate mood names in an 8-by-8 grid); this text appears to work well as an adjunct to the color and positional indication, but is not sufficient on its own to quickly communicate a character's mood.

It is interesting to note that these four quadrants correspond to the four medieval humors thought at the time to govern an individual's internal emotional and physical balance: sanguine (high-energy happy); phlegmatic (low-energy happy); melancholy (low-energy unhappy); and choleric (high-energy unhappy). While this cannot be taken as anything more than an anecdotal correspondence, it highlights the fact that in devising systems to simulate or emulate emotions and moods, there is little more than personal experience and anecdote in the literature to base these on. The popular OCC model is itself an analytic approach to defining emotions by separating their referents - a paradoxically logical approach to quantifying what are ultimately qualitative states. An important area for continuing research is in devising emotional systems that are progressively more recognizable, complete, and predictable from the point of view of multiple, cross-cultural studies with humans.

The Mind Module

The Mind Module (MM), is a semi-autonomous agent architecture built to be used in a multiplayer environment as a part of the player's avatar (Eladhari, 2009). It can also be used with autonomous characters, but here we focus on its application to player characters. The MM models the avatar's personality as a collection of traits inspired by the FFM, maintains dynamic emotion state as a function of interactions with objects in the environment and trait values, and summarizes the avatar's current emotional state as an inner and outer mood.

Affect Nodes

The current iteration of the MM consists of a weighted network of interconnected nodes of four types: traits, emotions, sentiments and moods as shown in Figure 2.

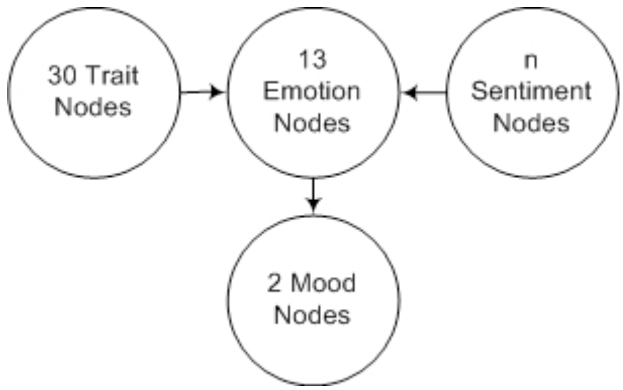

Figure 2 Affect Node Types

As discussed in (Eladhari, 2009) emotions can be regarded as brief and focused (ie. directed at an intentional object) disposition, while sentiments can be distinguished as a permanent and focused disposition (Moffat, 1997). Similarly, mood can be regarded as a brief and global disposition, while personality traits can be regarded as a permanent and global disposition. Hence emotion, mood, sentiment and personality are regions of a two-dimensional affect plane, with focus (focused to global) along one dimension and duration (brief to permanent) along the other as illustrated in Figure 3 (Eladhari, 2009). A value of a node with a fast decay rate is non-zero for only a short period of time after the 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.

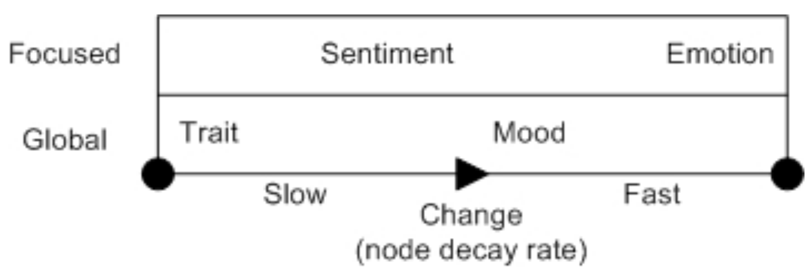

Figure 3 Two-dimensional affect plane

Personality and Emotions

The personality of a character defines the nature and strength of the emotions a character "feels" in different contexts. The MM equips each avatar with 30 trait nodes, inspired by the FFM, as shown in Table 1. The traits are grouped into five factors, with the value of a factor being a weighted linear combination of the values of the traits (Eladhari, 2009).

The choice of the 13 emotions (listed in the Mood section below) used by the MM emotions is based on research into affects and affect theory by Tomkins (1962), Ekman (1994) and Nathansson (1992).

Through a mapping of weightings between emotion nodes and trait nodes, the MM defines how much the value of an emotion node fluctuates for each avatar. For example, the emotion node Amusement is connected to four trait nodes with the following weightings: Cheerfulness: 1.1, Depression: 0.9, Imagination: 1.2 and Emotionality: 1.1. Thus, stimuli that would lead to Amusement will lead to more Amusement the higher the trait values for Cheerfulness, Imagination, and Emotionality, and less Amusement the higher the trait value for Depression.
Systematic information about effects of personality on emotion applicable for the MM is scarce. The current weightings between traits and emotion is experimental and is evaluated with the goal to create interesting game play experiences rather than simulating a set of beliefs of about the workings of the human mind.

Mood

The mood is a processed summary of current state of a character's mind (Eladhari, 2009). The mood of a character is measured on two scales that are independent of each other, an inner (introvert) and an outer (expressive). Each scale ranges from -50 to 50; this corresponds to Depressed to Bliss on the inner scale, Angry to Exultant on the outer scale as shown in Figure 4.

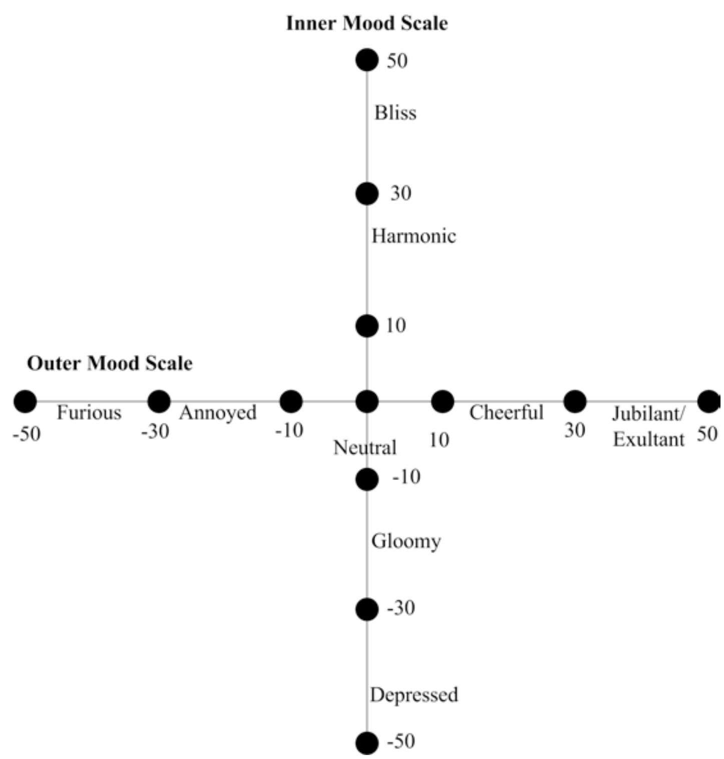

Figure 4 Mood matrix

The inner mood is 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. Reversely, 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 as such tied to emotions that are typically not only directed towards another entity but also often expressed toward an entity, such as anger or amusement. The two scales for the mood nodes open up the possibility of more complex states of mind than a single binary axis of moods that cancel each other out. The weightings between the mood nodes and the emotion nodes are shown in Table 2.

Table 2 How the mood scales are affected by emotions.

Emotion	Weight to Inner Mood	Weight to Outer Mood
Amusement		+ 2
Interest -Excitement		+ 1.5
Enjoyment – Joy	+ 2	+ 2
Relief	+ 1.5	+ 1.5
Satisfaction	+ 2	
Surprise	+ 1.5	
Confusion	- 1.5	
Distress – Anguish	- 2	- 1.5
Fear – Terror		- 2
Anger – Rage		- 2
Shame – Humiliation		- 1.5
Sadness	- 2	- 2
Guilt	- 1.5	- 1.5

The weightings in Table 2 are those tested in the prototype and described in this paper, and are subject to change. Just as with the mapping between traits and emotion there are few sources in psychology to draw upon for these details, and since the purpose of the implementation is to facilitate game play experiences rather than a true simulation of the human mind, the iterations of this aspect of the MM is tested and reiterated accordingly.

The real-time, or current, mood of the character is dependent on the nature and strength of the emotions the character has experienced the past hours. The strength of the emotions is different for different characters depending on their personality traits. The nature of the emotions differs depending on what sentiment nodes the characters have toward other entities in the context. Hence two characters going through a similar series of events potentially have different emotional experiences and therefore end up in different mood spaces.

Sentiments - Emotional attachments

A player character can have emotions associated with game objects. For example, a character with arachnophobia would have the emotion Fear associated with objects of type Spider. Such associated emotions are called sentiments. These are represented in the MM via sentiment nodes that link emotion nodes to specific objects or object types. Thus, if the player's avatar has a sentiment of Fear towards Spiders, and a Spider comes within perceptual range, there will be an immediate change in the value of the Fear node; the exact value of the change will be a function of the strength of the sentiment as well as the values of the traits that modulate the value of Fear.

The sentiment nodes of the MM allows several sentiments of different emotions to be attached toward another entity, thus creating a compound set of sentiments. Sentiments can in a game world context be created several ways. The *emergent sentiments* originate from interactions with other entities in the world, thus creating emotional memories. The *authored sentiment sets* have certain pre-set combinations. For example “infatuation” is a combination of interest/excitement/amusement and joy toward another character. The authored sets of sentiments have a longer decay rate than those emerging from interaction.

The MM thus provides the player with information about the avatars feelings toward other entities in the world. Proximity to objects or characters effect the emotions, and thus the mood of an avatar, functioning as information the player can use to form an agenda for game play. Thus, in comparison to DPE, the MM relies more on the player's own goal formulation.

Case study: Affecting the mood of a character using Affective Actions
In order to explore how players would take to the use of mood in a social game play context we devised a test scenario in a paper prototype (see Figure 5).

Figure 5 Guided paper prototype play test. A player is using an affective action.

World of Minds
The context for the test was World of Minds (WoM), a prototype game world where the personalities of the inhabitants are the base for the game mechanics (Eladhari, 2009). When interacting with other characters, the reactions depend upon the player character's current mood and personality.

The basic game play of WoM is simple: Players need to defeat physical manifestations of negative mental states. In order to do so, they can cast spells on them, but the spells available are constrained by the avatar's personality, her current mood, and how far the avatar has progressed in learning new spells. Each avatar has mind energy (mana) and mind resistance (hit points). Each spell costs mind energy to use, and attacks reduce mind resistance. The experience of the character defines how large the possible pool of energy and resistance is at a given moment. The regeneration rate of resistance depends on the inner mood, while the regeneration rate of the energy depends on the outer mood, as shown in Figure 6 (Eladhari, 2009) .

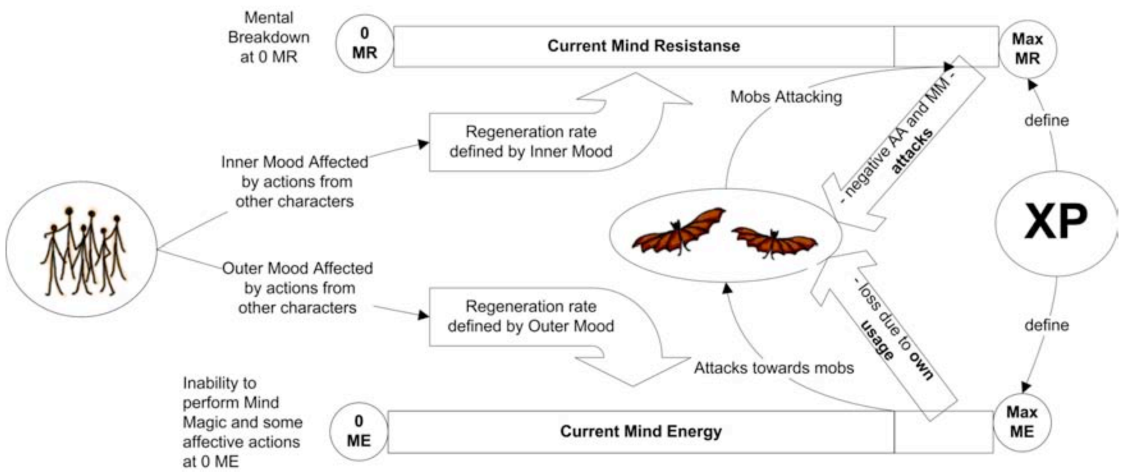

Figure 6 Fluctuations of Mind Energy and Mind Resistance

A central feature in WoM is that players can affect each other's moods by using Affective Actions (AAs). AAs are actively chosen by the players – they are not effects of other social actions. If a player targets another avatar she can choose from a selection of AAs. For example the AA Comfort can be used successfully on targets that have an active emotion node of Sadness, but only if the player's own avatar is not in the area of Furious on the mood matrix. If the AA Comfort is used successfully, the values of the emotion nodes Sadness and Anguish of the target are diminished, which in turn affects the mood of the character (Eladhari, 2009) .

Sentiments for avatars in WoM are generally instantiated as a result of a player character's action or of a result a player's choice. In the current implementation sentiments are instantiated when an emotion node reaches a threshold value, in most cases set as 90% of its maximum.
Figure 7 is an illustration of how an affective action or a spell causing amusement is interpreted by the MM (Eladhari, 2009) . The values on the arrows between the nodes are weights.

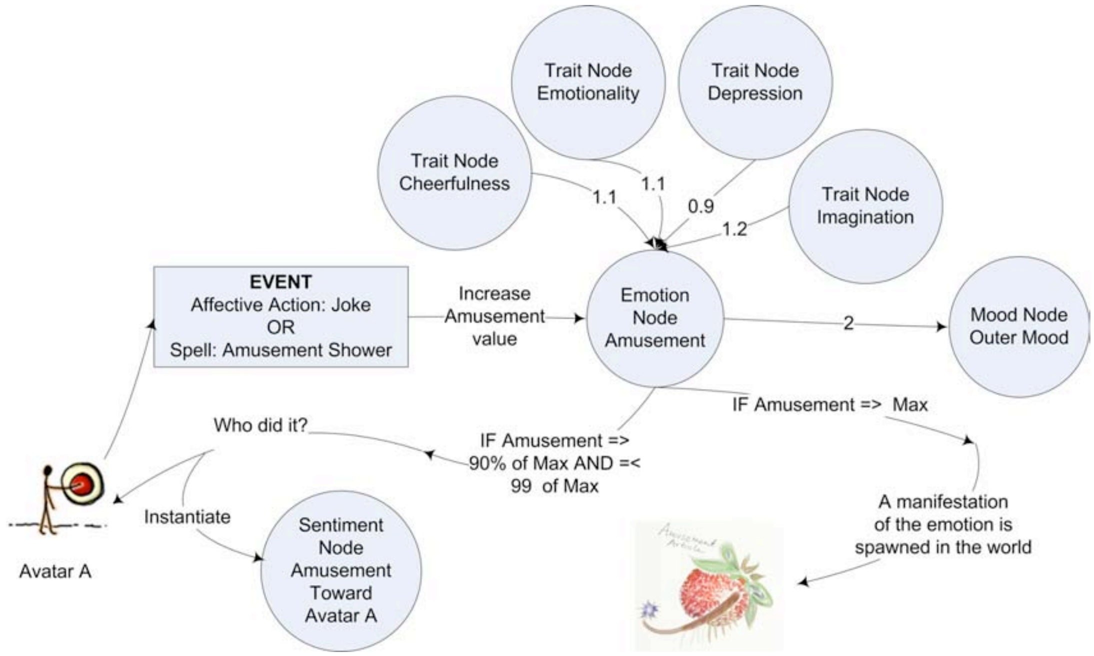

Figure 7 An example of how an amusing action is interpreted by the MM.

Play-test

Our approach for evaluating the game design via a paper prototype draws on User-Centered Design, where the user's experience is a main driver for design, as well as from rapid prototype and playtesting approaches that are becoming more common in game design (Fullerton, 2004). During the playtests, the test leader walks individual players through a paper simulation of several scenarios. Players are asked to think aloud while playing the game; additionally, the test leader stops the game at several points and conducts interviews. Our approach is described in detail in (Koivisto, 2006).

Ten players individually went through five game mastered scenarios where her avatar had a mind, represented by the character sheet as shown in Figure 8.

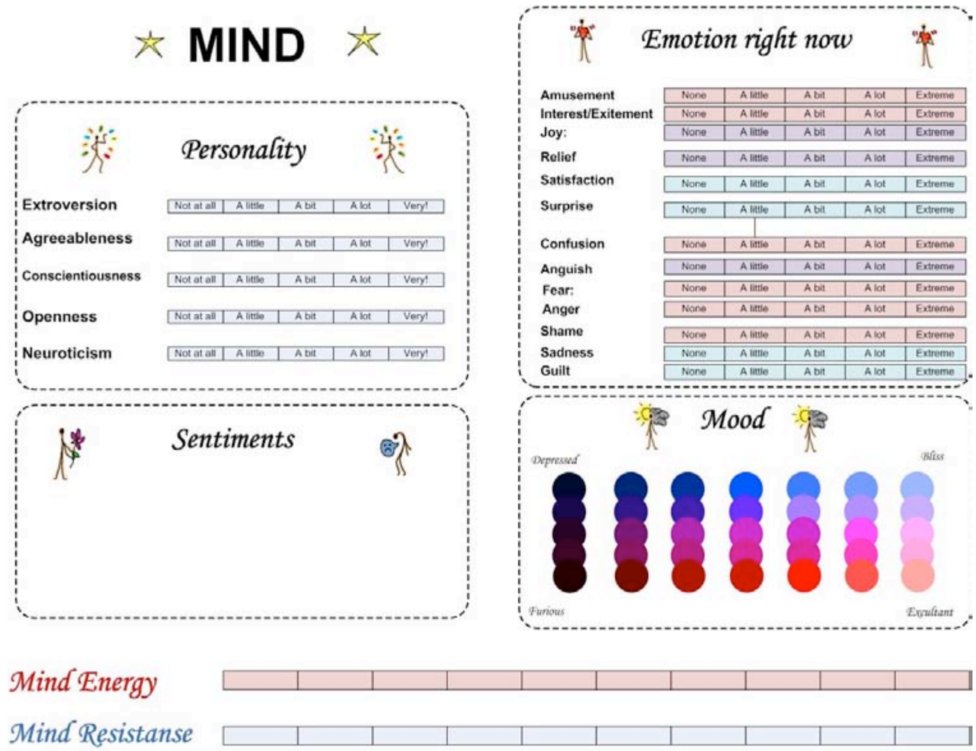

Figure 8 Mind Sheet used in playtest of WoM.

During the five scenarios, also described in (Eladhari, 2009), the player was guided through using the main categories of actions in the game, including affective actions, navigation in a landscape of sentiment, and mind magic spells. Using the character sheet (Fig. 8), the test leader updated the state of mind of the avatar and NPCs, showing the player the effect of her actions in the game in terms of fluctuations in emotions, mood, mind energy and mind resistance. In order to best capture player's problem-solving processes within the game, and to best understand potential areas for confusion, the players were given minimal explanations about how and what to do. At any point, players could access a "help system" in order to ask any question. The twenty-two interview questions focused on the player's understanding of the relationship between values in the MM, effects of game actions, relationship between personality and availability of actions such as spells, etc.

For each playtest, the participant:

- Filled in a short (less than ten questions) survey on demographic data and previous gaming experience.
- Took the IPIP-NEO Personality test and emailed the results to the test leader.
- Filled in a short survey about their experience taking the personality test and their opinions about the use of personality traits for avatar creation.
- Participated in the playtest, which took between 1 and 1.5 hours. Each playtest session consisted of playing five scenarios, and answering questions in two interviews, one in the middle, and one at the end of the playtest. Each session was videotaped.
- Filled in two more short surveys, one focused on sentiment objects, and the other on

general impressions of the experience.

We used the video analysis tool Transana to analyze the 15 hours of video of interviews and play sessions. We developed a coding scheme for potentially relevant phenomena and states of mind; this provided us with the initial framework for searching for patterns and regularities, as advocated by Miles and Huberman (1994).

Players and affective actions

The scenario that was most interesting for results regarding the mood feature was where the player met the character Teresa, who was played by the game master. Teresa had an identical character sheet but with values showing that she was depressed. She introduced the player to the use of Affective Actions (AAs) by saying that she was very sad, and asking for a hug.

Seven of the players chose to hug Teresa, while three of them started the chain of AAs in the scenario with using “Comfort”. The AA “Comfort” would diminish the emotions of sadness and anguish in the targeted character. No one chose the AA “Look at target with dismay” which would have created an increase in the nodes confusion and sadness. Some AAs were to be used in a reciprocal fashion, such as “Joke” where the target could respond by either “Laugh at joke”, or “Refuse to laugh at Joke”. Using such an AA included a risk, since if the target chose (or was forced) to refuse, the effect on the joker would be an increase in distress and sadness. Laughing on the other hand would give both the joker and the target an increase of amusement, plus an increase in the satisfaction node of the successful joker. However, if the target of the AA “Joke” had her mood marker in the leftmost row in the mood matrix (Figure 4) it was not possible to use the “Laugh at Joke” reciprocal AA.

The players enjoyed monitoring the fluctuations of the mood in their own avatars and Teresa and experimenting with different AAs. This scenario, one of five, was the most popular one: the majority of the players pointed it out as their favorite part of playing the prototype. Several of the participants used the expression “make sense” when discussing the mood feature in relation to the affective actions in the interviews conducted in relation to the tests.

Comparison of Mood representation in DPE and MM

The two scales of the mood matrices of DPE and MM are similar despite many differences in the details in the underlying systems. Both create a spatial representation with the extremes of anger, despair, exultation, and bliss, though each organizes the underlying axes differently. MM differentiates between inner and outer mood, while DPE puts both internal and social emotions in the same mood-space. Affect in the DPE is valence-neutral; that is, it is part of positive and negative moods alike. This is somewhat analogous to the change between inner and outer mood in MM, but the analogy can easily become strained. One aspect of modeling emotions and moods that is clear in both cases, and which was pervasive in our discussions, is the lack of clear terminology for referring to qualitative emotion and mood states. This hinders literature comprehension, design, and comparison between models.

Conclusions

We have presented two systems that simulate the minds of virtual characters where their moods are displayed as the aggregation of multiple underlying emotions. Unlike personality traits the mood depends on the context, just as emotions, but the mood lingers, bringing the emotional memory of recent experiences into the contexts and thus enriching an environment where characters appear more plausible than in the virtual game worlds to date. Players may use this information about their own avatar and other characters in the game in order to interpret the internal state of that character, determine what kind of actions can be performed, or interpret what interactions would be appropriate in a given context. Guided play tests show that despite issues of naming moods, users find their graphical and textual display useful in game play situations that use metaphors of social interaction.

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