A Framework for Creating Non-Player Characters That Make Psychologically-Driven Decisions

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***Abstract*—The behavior of non-player characters (NPCs) affects player immersion and, by extension, engagement. A realistic NPC can provide great satisfaction to the completion of the story a game is attempting to tell; but an unrealistic NPC can spoil the entire experience. Numerous systems have been developed to build NPCs with psychological underpinnings. These tools can be based on one, or some combination of emotion, mood, personality, or memory. This article describes a framework that incorporates these psychological components. This framework can be used to create NPCs that exhibit psychologically-driven behaviors and make decisions based on a combination of their emotions, moods, and personalities.**

Keywords—non-player characters, emotion, mood, decision-making, EmoBet framework

I. Introduction

NPCs are part of the story a game is trying to convey and if the NPCs are not performing their roles in the story adequately, then it can negatively affect how the player experiences the story and by extension their immersion and engagement [1]. Immersion, or lack of it, is a large contributor to the success or failure of a game [2]. As a player becomes immersed in a game, they often tend to lose track of time playing the game, which directly speaks to the level of engagement and enjoyment derived from it [3].

Given that NPC believability plays a large role in player immersion and engagement, a possible solution to the immersion issue is to improve NPCs. Good decision making by NPCs is one key to believability. In this paper we discuss how the Emotion Behavior Tree (EmoBeT) Framework can create NPCs that are motivated by their emotions, moods, and personalities and make judgments based on these factors.

II. Background

Popescu, Broekens and Someren state that if emotions are included in NPCs, then this will lead to an increase in the variation of NPC behavior—creating a more interesting game [4]. Hudlicka and Broekens agree and add that both entertainment and serious games can benefit from the addition of more believable NPCs by using emotions [5]. Gebhard goes even further and states that emotion, mood, and personality represent short, medium, and long term affect respectively. They all play a role in influencing different facets of human behavior, and that all three have a role to play in creating a more believable NPC [6]. We will take a brief look at the theories associated with these aspects of human behavior.

A. Emotion and Emotion Theories

Emotion is the most popular form of affect used when creating psychologically based NPCs. It can be defined as: (i) any psychological involvement in high intensity content [7]; (ii) a unique state of simulation which is triggered by some process [8]; or (iii) "valanced reactions to events agents, or objects, with their particular nature being determined by the way in which the eliciting situation is construed" [9]. These definitions all consider emotion to be a mental state [7].

In addition to multiple definitions of emotion there are several emotion theories. Plutchik [10] is one of the most highly cited emotion theories. It states that evolutionary development was the basis of the primary emotions. Secondary emotions can be derived from, or be combinations of, primary emotions. The primary emotions are opposites of each other and can be paired, for example: Joy vs. Sadness; and Fear vs. Anger.

The Ortony, Clore and Collins Model (OCC Model) [9] is the most commonly used theory for designing believable agents with emotions. The theory defines twenty-two emotions ranging from Joy to Hate and includes the concept of emotion intensity.

B. Mood Theory

Mood is not as thoroughly researched as emotion–even though the two are both forms of affect and can affect each other. As a result, there are few mood theories and a dearth of examples where these theories are applied to psychologically-based NPC design.

The Pleasure-Arousal-Dominance (PAD) emotional and temperament models proposed by Mehrabian are used to connect and map the emotions with the more stable emotional states (moods) of a person [11]. In the PAD model, all emotions and moods are divided into three dimensions that have both positive and negative valences. Pleasure (P)/Displeasure is the state of liking or disliking. Arousal (A)/Non-Arousal is physical or mental alertness. Dominance (D)/Submissiveness is how in- or out-of-control one feels. These three almost-independent dimensions form the mood space with 1 as the maximum and -1 as the minimum values. The mood space is also split into octants.

C. Action Selection in NPCs

Action selection is a factor that impacts NPC believability. If the choices made by an NPC can be seen as reasonable, it may then seem to be more realistic or human-like. Conversely, implausible choices decrease NPC realism. There are many Artificial Intelligence (AI) techniques that have been implemented in games to handle NPC action selection. These include Finite State Machines (FSMs), Behavioral and Decision Trees (DTs), Cognitive Architectures, and neural networks.

III. Related Work

Laureano-Cruces et al. implemented a model in the form of a cognitive module that is attached to a game [12]. The module considers the emotions that the NPC feels and then triggers the appropriate action. Emotions are predefined in this game and are activated by either the player, the environment, or the goals of the NPC. NPCs can reorder their goals based on their emotional state.

Waltham and Moodley [13] implements an emotional Behavior Tree (BT) as proposed by Johansson and Dell'Acqua [14]. Instead of creating additional nodes, they instead include a fuzzy state machine that places the emotional parameters and the emotional state of the NPC into the BT. The states of this fuzzy state machine represent a different emotion, and due to how fuzzy state machines work, this allows the NPC to feel multiple emotions at any given time. Subagyo, Nugroho and Sumpeno [15] also implement the emotional BT as described by [14]. They use the emotional BT to plot how a person's decision-making would be affected in a fire evacuation scenario. Their main aim was to see how different emotions affect the NPCs in the scenario.

The GAMYGDALA Emotion Engine is an AI sub-component that adds emotion to NPCs [4]. Taking the current event that it is experiencing into consideration, GAMYGDALA will elicit a suitable emotion for the NPC based on the OCC model of emotion. GAMYGDALA is used in the game Phaser, in cognitive agent programming, and an affective storyteller [16]. However, it does not consider how certain emotions should be combined.

The PSYCH framework [17] proposes a method to make NPC-NPC interaction more dynamic and unscripted. The framework makes it possible for players to "inhabit" an NPC in a game and interact with other NPCs in a psychosocial setting. This allows the player to affect NPC-NPC relationships, which can affect the outcome of a game. The framework indicates that it can use psychometrics that include emotion and mood; however, most of the work focused on emotions triggered by the inhabited NPC and its effect on pre-existing psychosocial relationships.

Baffa et al. [18] propose a model based on personality and emotion to demonstrate how the personality of the NPC affects the emotion it presents. Decision-making is achieved using state machines. The model employs the Plutchik emotion theory and does not include mood in the decision-making process.

Finally, the Artificial Psychosocial Framework proposed by Klinkert and Clarke [19] seeks to achieve the same goal as our proposed EmoBeT framework. It integrates with the Unreal game engine and can work with AI decision-making techniques such as behavior trees. It uses the OCC emotion model combined with the OCEAN personality model. However, it does not evaluate the effect mood has on decision making.

There are very few systems that only implement emotion and mood–omitting the other psychological facets. This is mainly because mood is not generally viewed as important as the other forms of affect such as emotion or personality. The Mood Vector Space (MVS) based on the PAD space framework and the OCC Model of Emotions is presented in [20]. The main contribution of the approach in [20] is that it builds on the OCC [9] and PAD models [11] to create a formalism to link emotion and mood. We have also sought to combine emotion and mood within our system; however, we use an extended behavior tree as our model.

A. Summary

We believe that systems that implement emotion and mood have the potential to better replicate the intricacies behind human-like behavior; but very few systems include mood. As humans, mood and emotion are two of the major factors that influence the decisions we make; we believe that they should also play a similar role in NPCs decision making.

IV. Design and Implementation

The EmoBeT Framework is based on the ALMA Model of Affect [6]. ALMA was chosen because it is capable of modeling affect. Written in Java, ALMA creates conversational agents that use emotion, mood, and personality. Since we aimed to create non-player characters that functioned using behavior trees, we ported ALMA to C++ and extracted its affective elements–removing unwanted functionality such as the GUI and other external files.

Like [14], our project introduces new BT nodes; however, the EmoBeT Framework uses multiple psychological theories to inform its implementation while none are used in Johansson and Dell'Acqua [14]. An extended behavior tree and memory capabilities were integrated with the affective module. This integration changed it from a conversational agent into an action-selection module, which creates affective NPCs that could be used by game developers.

The EmoBeT Framework is intended to be a tool that game developers can use to integrate emotion, mood, personality, and memory into NPC decision making to create psychologically-driven NPCs [21]. Mood was selected as the catalyst for decision making to bring an element of serendipity. An overview of the key modules that make up the EmoBeT Framework is provided below. Because the focus of this paper is the effect of emotion and mood on decision making, we will treat personality more as a mood initializer than as a separate factor. Therefore, we will discuss the personality subsystem–even though it will not be used in further discussions in this paper–for the sake of completeness.

A. The Character Manager Module

The Character Manager Module represents the NPC, Figure 1A. This module contains the helper functionality that connects the other modules to the NPC. It also manipulates the other modules for the NPC's action selection.

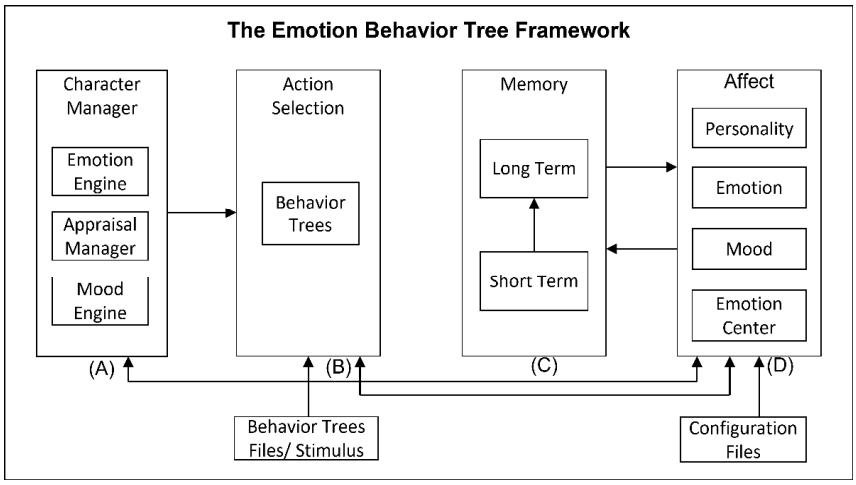

Fig. 1. The Emotion Behavior Tree Framework

1) Emotion Engine

The Emotion Engine takes the conditions prepared by the appraisal manager to create the corresponding emotion. It then adds this emotion to the emotional state of the NPC.

2) Appraisal Manager

The Appraisal Manager determines the condition of the NPC before an emotion is elicited. This happens after the NPC has experienced an event that will trigger an emotion, but before the emotion has been triggered. This module acts as a processor that sorts conditions so that the NPC can create and feel an emotion based on the event experienced.

3) Mood Engine

The Mood Engine is a helper module that updates the mood of an NPC after the Emotion Engine updates the emotional state.

B. The Action-Selection Module

The Action-Selection Module, Figure 1B, implements the behavior tree extensions–the Emotion Adder and the E-Selector. These two nodes connect the behavior tree with the EmoBeT Framework and supports the enhanced decision-making of the NPC.

- The *Emotion Adder* node adds emotions to the behavior tree. It represents the point at which an emotion is triggered within an NPC.
- The *E-Selector* node reads the NPC's current mood and triggers a reaction. The reaction is predefined by the programmer, who determines which reaction correspond to each mood the NPC experiences.

For more details on the extended behavior tree see [21].

C. The Memory Module

The Memory Module, Figure 1C, provides the NPCs with the ability to recall their previous interactions and the emotions that were triggered by them. Memory is divided into long- and short-term memory and the inputs from the environment are used as sensory memory.

D. The Affect Module

The Affect Module, Figure 1D, handles all facets of the emotion, mood, and personality. This module oversees the creation of emotions felt by the NPC, the initialization of mood and personality, and any interactions between the three forms of affect.

1) The Personality Subsystem

Personality profiles are created for every NPC. Personality is implemented as a long-term affective state, and once defined, it is fixed for the life of the NPC. In this framework, personality is based on the five personality factors as defined by McCrae and John [22]. Each NPC has a personality profile that defines their personality. This definition consists of five variables representing the five facets of the five-factor model: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. The programmer is provided the option of randomly generating these values or defining them themselves. Both options limit the values to between -1.0 and 1.0.

2) The Emotion Subsystem

Emotions are used in the framework to influence and regulate the mood of the NPC–and by extension its decision making. The framework handles: (i) emotion types; (ii) emotion intensity; and (iii) emotion elicitors.

a) Emotion Types

A tweaked OCC model of emotions is used. It consists of the 24 emotion types ranging from Joy to Hate. We added the *Undefined* emotion type, to our model to represent OCC-defined emotions that were unknown to the NPC. Emotion types are used to differentiate how the NPC is feeling and to access the appraisal information related to that emotion.

b) Emotion Intensity

Emotion intensity is used to determine the impactful of an emotion. The higher the intensity, the greater the emotion's effect on the mood. The base intensity of an emotion is pre-set. The other factor that dictates emotion intensity is the NPC's personality. For example, the mood of an NPC with a highly-neurotic personality will be more affected by negative emotions than an NPC with a low-neurotic personality. This is

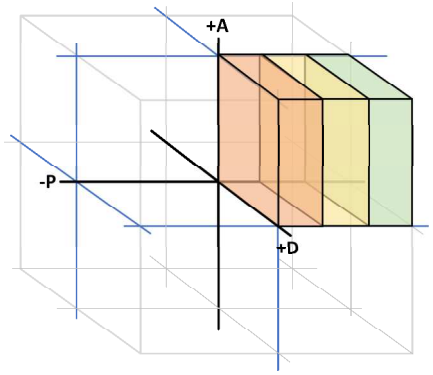

Fig. 2. Mood intensity in the +P+A+D octant showing the slight (red), moderate (yellow), and full (green) intensity segments.

accomplished by modeling the relationship between emotions and the influence the five personality factors have on them.

c) Emotion Elicitors

The events that cause emotions to be created are stored within the emotion itself. These are known as the Elicitors. Elicitors represent the emotion trigger, and these triggers can either be external or internal. External triggers result from interactions the NPC has with its environment. These include the words and actions of the player. These interactions are introduced to the NPC via the behavior tree. Internal triggers are caused by recalling a previous experience with the player. These internal triggers reference the information stored within the elicitor to remember the cause of an emotion stored in memory.

3) The Mood Subsystem

Mood is the second affective state in the EmoBeT Framework. It is a mid-term affective state, which means that its duration is longer than that of an emotion, but it is not permanent. It is also the most important element in framework for deciding how an NPC will behave since the mood determines all actions. This subsystem uses the PAD model of temperament [11], which includes the mood type, and mood intensity–categorized as slightly, moderately, and fully. It is also responsible for updating the mood.

a) Mood Type and Intensity

The mood is determined by the positive or negative valence of the PAD values of its mood. As mentioned in the Background section, mood values fall between -1 to 1. Depending on where the mood is in an octant, it will have one of three keywords to describe the mood intensity: slight (mood is in the first third of an octant), moderate (mood is between the first and last third of an octant), and full (the mood is within the final third of an octant), see Figure 2.

b) Mood Update

After the emotion is created and added to the emotional state, the newly updated state of the NPC is used by the Emotion Center to determine the impact it has on the current mood of the NPC.

4) The Emotion Center

The Emotion Center is closely linked with the emotion and mood modules. It plays a vital role in determining the mood. It works with the current mood and emotion to determine the future mood of the NPC. It is a combination of every emotion felt since the NPC's creation. Given that it is purely made up of emotions, it can be mapped into the same 3D space as the mood, which means that the Emotion Center can be represented by a PAD value.

TABLE I. THE TABULAR FORM OF THE BEHAVIOR TREE FOR THE EXPERIMENT 1 GAME SCENARIO

Dialog Stages	Player Choice	NPC Emotion / Reaction	Dialog
1	+ve	-	"NPC come save me please. I need you"*
	-ve	-	"Come help me, what do you think I brought you here for?"
		+ve Emotion	Pride*
		-ve Emotion	Resentment
		+ve Reaction	"I'll save you don't worry"
		-ve Reaction	"Seems you do need me after all"*
2	+ve	-	"Thank you"
	-ve	-	"Damn it, just do your job"*
		+ve Emotion	Satisfaction
		-ve Emotion	Reproach
		+ve Reaction	"I'll save you"
		-ve Reaction	"I'm leaving you to die!"*

E. Data and Control Flow

In summary, after the emotion is created by the Emotion Adder it is included in the Emotion Center, which calculates the new mood of the NPC. The E-Selector queries the newly updated mood of the NPC and uses the new mood state to determine the course of action to be taken. The Emotion Adder is shown outside of the NPC internal process because it handles player dialog and other external factors that affect the NPC. The E-Selector is treated as part of the NPC's internal deliberative process as shown in Figure 3. Memory is also an internal deliberative process; however, we will not be discussing the memory functionality available in the framework in this paper.

V. RESULTS AND DISCUSSION

Given the capabilities of the EmoBeT Framework we want to determine if emotions and mood influenced the NPC's decision-making capability.

A. Experiment 1

To test the EmoBeT Framework, we designed a toy scenario that typically occurs in role-playing games where the player has

TABLE II. MOOD AND EMOTION CENTER CHANGES

		Initial Values	Emotions Elicited	
			Pride	Reproach
Emotion Center	Pleasure	-0.42095	-0.33683 ▲	-0.43047 ▼
	Arousal	0.312057	0.327544 ▲	0.441583 ▲
	Dominance	-0.06579	-0.02741 ▲	0.123884 ▲
Mood PAD	Pleasure	-0.44123	-0.60433 ▼	-0.69795 ▼
	Arousal	0.12123	0.279841 ▲	0.525093 ▲
	Dominance	-0.19916	-0.21243 ▼	0.071776 ▲
Mood Description	Mood	Anxious	Anxious	Hostile
	Intensity	Slightly	Moderate	Moderate

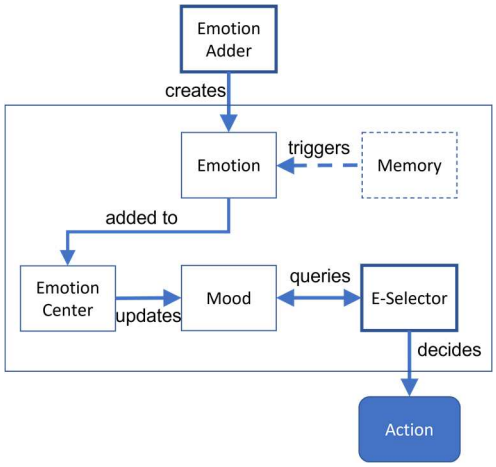

Fig. 3. Data and control flow in the EmoBet Framework showing how emotion and mood result in an action being taken by the NPC

a simple conversation with the NPC. In the scenario, the player could choose what he or she wanted to say to the NPC. Each choice was linked to, and could elicit, a different emotion in the NPC. These elicited emotions then impacted the mood and by extension the response the NPC chose in the scenario. The scenario acted as the test bed for us to evaluate whether the EmoBeT Framework achieved our goals. Although the framework's mood system can represent eight moods with three different intensities, for these experiments we simplified the process by limiting the moods to positive and negative valences.

Table 1 shows the tabular format of the executed extended behavior tree. The reader is referred to [21] for further details on how the tabular form relates to the extended behavior tree. The decisions made by the player and their corresponding emotions are denoted by an asterisk (*).

Table 2 shows the inner state of the NPC from the beginning of the scenario and as it progresses. The Emotion Center and Mood consists of the three PAD factors, which allows both the Emotion Center and Mood to be placed within the same 3D space. Within the EmoBeT Framework, all changes to the Emotion Center occur after the NPC feels an emotion. The Mood was then impacted and changed by the newly updated Emotion Center. In Table 2, any increase in values is denoted by an upward facing triangle, while any decrease is denoted by a downward facing triangle.

The first experiment focused on the determining whether the framework can create NPCs with emotions that impact mood, and consequently, for that mood to impact the decision-making process. The results in Table 2 show that when emotions are elicited through the Emotion Center, these emotions impact the mood of the NPC, and that different emotions affects the NPCs mood in different ways. This is seen in Table 2. When the emotion Reproach was elicited the NPC mood changed from being Anxious to Hostile. Since the mood is the determining factor for decision making as indicated in Figure 3, this showed that both emotion and mood were able to influence the decision-making process.

TABLE III. MOOD AND EMOTION CENTER CHANGES FOR THE NPC WITH LOW NEUROTICISM

		Initial Values	Emotions Elicited			
			Joy	Hope	Gratitude	Resentment
Emotion Center	Pleasure		0.4	0.3 ▼	0.4 ▲	0.33097 ▼
	Arousal		0.2	0.2	0.275 ▲	0.20885 ▼
	Dominance		0.1	0.0 ▼	0.025 ▲	-0.00088 ▼
Mood PAD	Pleasure	0.305	0.405 ▲	0.605 ▲	1.0 ▲	0.548 ▼
	Arousal	0.685	0.735 ▲	0.935 ▲	1.0 ▲	0.548 ▼
	Dominance	0.268	0.293 ▲	0.293	0.318 ▲	0.17426 ▼
Mood Description	Mood	Exuberant	Exuberant	Exuberant	Exuberant	Exuberant
	Intensity	Moderate	Moderate	Moderate	Fully	Fully

B. *Experiment 2*

In the second experiment we wanted to determine whether the framework could create NPCs whose default mood plays a role in how they process emotions. We also wanted to verify that distinct NPCs created with dissimilar default moods will manifest different moods–and then make different decisions–when placed in the same situation. Recall that default mood of an NPC is initialized by its personality.

For this experiment, two NPCs with mostly similar personality traits were placed in the same scenario with the player treating them the same way. In the scenario, the player interacted with the NPCs to trigger the emotions shown in Table 3 and Table 4. The personalities were identical except for the Neuroticism value. The first NPC's default mood was initialized using a personality with a **high** Neuroticism value, while the second NPC's default mood was initialized using a personality with a **low** Neuroticism value. High Neuroticism implied that the NPC's mood would be impacted more by negative events when compared to the other NPC that had low neuroticism. A default mood caused by a low neuroticism value implied that the NPC was less disposed to experiencing negative emotions when compared to an NPC that was highly neurotic [23].

In both Table 3 and Table 4, the Emotion Center is blank since the NPC was just created and had yet to experience any emotion. Both NPCs were assigned different default moods based on their slightly different personalities. Both NPCs, as expected, had the same Emotion Center for the first three emotions Joy, Hope and Gratitude. Recall that both NPCs had similar default moods with the difference being caused by the personality trait Neuroticism, which resulted in the positive emotions of Joy, Hope and Gratitude affecting them the same way. Consequently, both NPCs had the same Emotion Centers values. As Joy was the first emotion experienced, the Emotion Center took on its PAD value and it changed when Hope and Gratitude were added to the pool of emotions. Since both NPCs had the same Emotion Center and their Moods were in the same

TABLE IV. MOOD AND EMOTION CENTER CHANGES FOR THE NPC WITH HIGH NEUROTICISM

		Initial Values	Emotions Elicited			
			Joy	Hope	Gratitude	Resentment
Emotion Center	Pleasure		0.4	0.3 ▼	0.4 ▲	0.28 ▼
	Arousal		0.2	0.2	0.275 ▲	0.16 ▼
	Dominance		0.1	0.0 ▼	0.025 ▲	-0.02 ▼
Mood PAD	Pleasure	0.495	0.595 ▲	0.795 ▲	1.0 ▲	0.35363 ▼
	Arousal	0.115	0.165 ▲	0.365 ▲	0.5039 ▲	0.20807 ▼
	Dominance	0.268	0.293 ▲	0.293	0.318 ▲	0.04139 ▼
Mood Description	Mood	Exuberant	Exuberant	Exuberant	Exuberant	Exuberant
	Intensity	Moderate	Moderate	Moderate	Moderate	Moderate

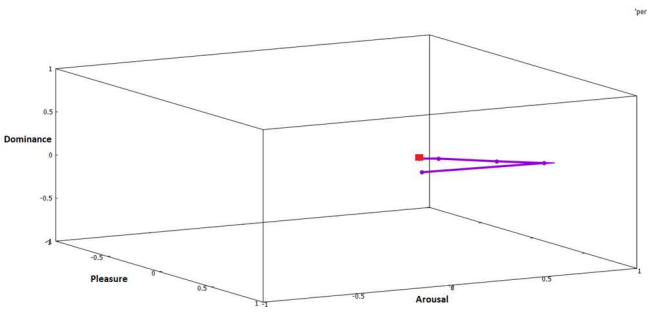

Fig. 4. A 3D representation of the mood change for the NPC with high neuroticism.

octant, both Moods were changed by the same amount for all three positive emotions. This can be seen when comparing Figure 4 to Figure 5.

Resentment is where the difference in mood was observed. The Emotion Center of the NPC with the mood initialized with a highly neurotic personality shown in Table 3 showed a greater reaction to the negative emotion resentment, when compared to the NPC whose default mood was created with low neurotic personality trait, see Table 4. All three Emotion Center values of the high neurotic default mood fell further than the values of the low neurotic default mood as expected. This difference in Emotion Centers translated to the current mood of the NPCs. This was most clearly seen in the Pleasure value. Before Resentment was elicited, both Pleasure and Resentment were at the maximum limit of 1. After Resentment was triggered, the NPC with the high-neurotic default mood had the most drastic change in current mood, see Figure 4 and Figure 5.

These results show that NPC default mood affects decision making because the NPCs with different default moods showed different intensities in their reactions to the same emotion. This in turn affected the current mood and decision making.

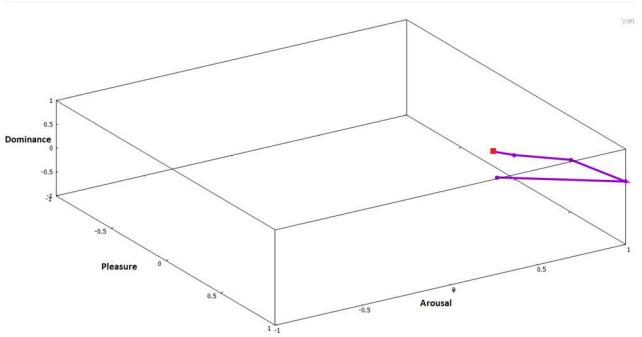

Fig. 5. A 3D representation of the mood change in Experiment 2 for the NPC with low neuroticism.

VI. Conclusions and Future Work

We have discussed some of the areas involved in creating NPCs capable of psychologically-driven decision making. The main areas we focused on were Emotion Theory and Mood Theory. In our related work review, there were no frameworks that incorporated emotion and mood to create NPCs capable of making psychologically-based decisions. We addressed this gap by designing the EmoBeT Framework. The emotion implementation was based on the OCC model while mood was based on PAD Mood Theory. We also implemented Personality and Memory theories but did not discuss it in this paper [9], [11], [22], [24]. We tested the EmoBeT Framework by creating NPCs and placing them in toy text-driven game scenarios.

The results showed that the decisions made by the player influenced the emotions elicited within the NPC. These emotions then played a role in impacting the mood, which played a key role in decision making. The results also showed a relationship between the NPC's default mood and how it processed certain emotions. This relation also demonstrated that default mood affected NPC decision making.

A. Future Work

In the future we will be looking to test the EmoBeT Framework more thoroughly within a game to evaluate its in-game performance, which would include both the decision-making of the NPCs in real time, and the speed of the EmoBeT Framework. We would also like to carry out tests to evaluate the impact our psychologically-driven approach has on NPC believability.

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