The Personality-Enabled Architecture for Cognition (PAC)

Stephen Read, Ph.D.[1], Lynn Miller, Ph.D.[2], Anna Kostygina[2], Gurveen Chopra[1], John L. Christensen[1], Charisse Corsbie-Massay[1], Wayne Zachary, Ph.D.[3], Jean-Christophe LeMentec, Ph.D.[3], Vassil Iordanov[3], Andrew Rosoff[3]

[1]Department of Psychology, University of Southern California, Los Angeles, California 90089-1061, USA
[2]Annenberg School for Communication, University of Southern California, Los Angeles, CA 90089-0281, USA
[3]CHI Systems, Inc., Suite 300, 1035 Virginia Drive, Ft. Washington, PA 19034, USA
{read, lmiller, kostygin, gchopra, jlchrist, corsbiem}@usc.edu, {wzachary, jclementec, viordanov, arosoff}@chisystems.com

Abstract

The Personality-enabled Architecture for Cognition (PAC) is a new modeling architecture designed to create Intelligent Virtual Agents (IVAs) with personality traits and cultural characteristics. PAC integrates theory and empirical data from personality psychology, social psychology, cognitive science, and neuroscience to build a model of personality that is based on fundamental underlying human motivational systems. Unlike existing models that attempt to build affective and personality factors as customizations or additions to an underlying formally rational symbolic architecture, in PAC personality directly arises from fundamental motivational systems integral to the agent.

Introduction

PAC (Personality-Enabled Architecture for Cognition) is a non-traditional cognitive architecture designed to represent individual behavioral variability originating from personality, emotion, and culture (Zachary, Le Mentec, Miller, Read, & Thomas-Meyers, 2005), in socially-intelligent characters in computer games and simulations. PAC focuses on processes that underlie social behavior and interaction. It combines results from multiple sources, ranging from psychometric work on the structure of traits (e.g., the "Big Five" dimensions commonly identified in personality psychology, see McCrae & John, 1992) to recent work in neuroscience, identifying specific brain systems for different motivational domains. It integrates these partial models to produce an articulated, general model of human behavior in which behavior is pervasively influenced by underlying motives. These motives are situationally activated, but individual agents have differing baseline activations for different motives. Once activated, motives are controlled through a hierarchy of control processes (e.g., approach and avoidance systems) that can also be set. In PAC, the activation dynamics of underlying motives frame the way in which behavior is constructed in a given situation. Thus, the motive dynamics give rise to persistent individual behavioral tendencies (or personality), based on individual agent's baseline activation levels for various motives and baseline sensitivities in control mechanisms: Agents varying in personalities result.

The activation of motives and the enactment of behavior depend on the application of social knowledge, which, in PAC, is encoded in narrative (story-like) structures. These narrative structures are used to make sense of the other agent's behavior, as well as encoding the agent's possible behaviors. Thus, these story structures convey many aspects of the shared social knowledge that is a key component of culture.

The initial implementation of PAC is presented in Zachary et al (2005), with discussion of simulations of a very simple counter-insurgency scenario. These simulations demonstrated that PAC-based IVAs with identical knowledge would generate a range of plausible behavior in the same situation simply based on their underlying personalities, expressed as differing motivational parameters. Further simulations (Read, et al., 2006a) using the same game environment showed the ability of PAC agents to experience and express different emotions, again with the same underlying knowledge base, based on varying personality parameters. Thus, the PAC architecture 'works' in the sense of creating a general mechanism for personality that could be used to generate behavioral variability that was attributable to individual personality. However, these earlier simulations were done with very simple scenarios, with limited behavioral choices. Here we wanted to test PAC in a more complex and realistic social situation, a "pick up" scenario in a bar.

The Theory Underlying PAC

PAC relates the structure of human personality to the structure and dynamics of human motivational systems, tying personality to basic processing mechanisms in a psychologically plausible way. This contrasts with most previous work on personality in intelligent agents.

One thread of work on personality in agents (e.g., Andre et al., 2000; Badler et al., 1997; Ball & Breese, 2000; Goldberg, 1997) simply represents a small number of broad personality traits (e.g., extroversion, neuroticism) as a variable that modifies the agent's behavior. However, decisions about how the trait should influence the agent's behaivor are typically ad hoc. Another thread tries to

capture personality by modeling individual differences in the motivational structure of an agent (see the OZ project at CMU (Bates, 1994; Bates, Loyall, & Reilly, 1992) and work at MIT by Maes (1990) and her students (e.g., Blumberg, 1994)). Unfortunately, this work has focused on agents with "animal - like" motivational systems, and largely ignored research on the personality and motivational structures of humans.

The work that is closest conceptually to the current model is Moffat's (1997) model of emotion and personality, *Will*. This model is related to Mischel and Shoda's (1975) cognitive-affective theory, which conceptualizes human personality in terms of constructs such as goals, competencies, and expectancies. However, Moffat's model is abstract and it is not related to the structure of human personality. Gratch and Marsella (2004) propose an approach similar to Moffat's but, they also do not relate their model to what is known about the structure of human personality.

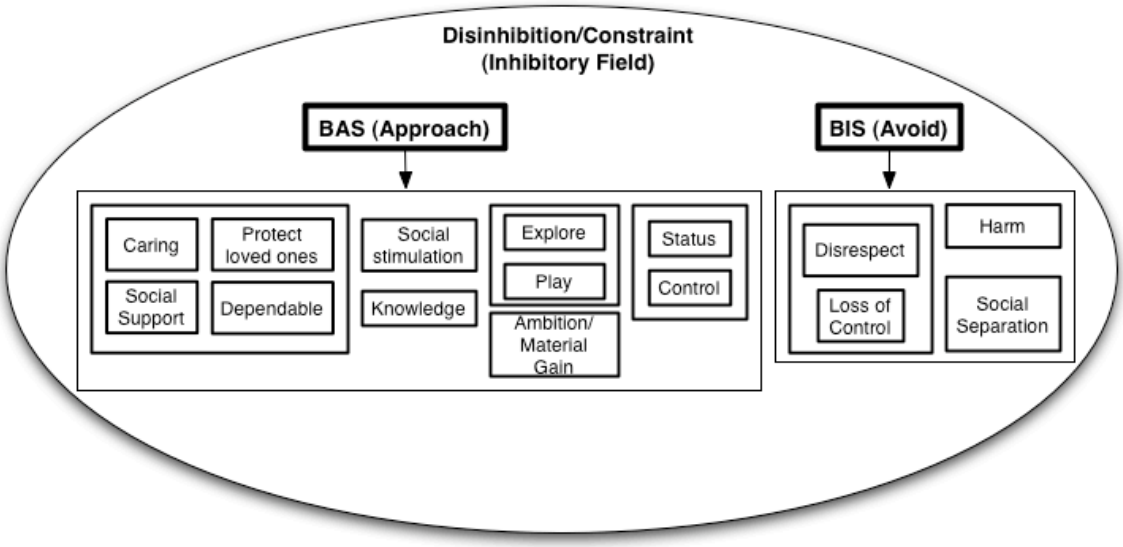

Fig. 1. Motive systems in PAC

The PAC combines theories and data from personality psychology, social psychology, cognitive science, and neuroscience to build a computational model of personality. *Personality* is defined as enduring tendencies to think, feel, and behave in consistent ways. Work on the lexical analysis of trait language (e.g., Saucier & Goldberg, 1996) and trait scales (e.g., Tellegen & Waller, 1997; Costa & McRae, 1992) has given rise to what is called the 'Big Five.' In this model, relatively narrow and specific traits are organized around five broad factors: Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (McCrae & John, 1992). Unfortunately, it offers little insight into the internal representations and processes that give rise to personality.

Two related lines of research enabled us to fill this gap (for a more detailed account see Read et al., 2006). One of these was work by Read and Miller (1989; Miller & Read, 1991) to identify possible cognitive constructs underlying personality. They noted how traits could be represented as configurations of motives, plans and beliefs: for example, "helpful" could be decomposed into the *motive* to help others, *beliefs* about whether others deserve help, *plans* to help, and needed *resources*. This ties the Big Five directly to the constructs used in cognitive simulation research.

A second line of research comes from recent findings in neuroscience and temperament (Clark & Watson, 1999; Depue, 1996; Pickering & Gray, 1999), which suggest that the motives central to personality are organized into two levels; namely, specific (or *level one*) emotional/motivational systems and broader, overarching (or *level two*) motivational systems. Mapping of brain circuits and neurotransmitter systems (Panksepp, 2000), and evolutionary analyses (e.g., Fiske, 1992; Kenrick & Trost, 1997) provide evidence for a set of *level one emotional/motivational systems* that handle the variety of major adaptive challenges that people must incorporate and pursue in everyday life. Among these adaptive challenges are: (1) social bonding, (2) fear of social separation, (3) dominance and the development of authority relations in groups, (4) exploration and play, (5) caring and parenting, (6) mating, and (7) self-preservation and concerns for physical safety. Each of these challenges corresponds to a motivational system that organizes a set of *specific motives*; these specific sets are the basis of the specific traits discussed above.

At a more general level are *level two overarching motivational systems* -- a Behavioral *Approach* System (BAS), which governs sensitivity to reward and *approach* to rewarding stimuli (and active exploration), and a Behavioral *Inhibition* System (BIS), which governs sensitivity to punishment and *avoidance* of threatening stimuli (Depue, 1996; Gray, 1987). There is considerable evidence that the broad *level two motivational systems* provide a biological basis for at least two dimensions of personality: Extroversion and Neuroticism. The biological

basis for extroversion is the sensitivity to reward in the BAS while underlying Neuroticism is the sensitivity to punishment or the desire to avoid threat that BIS mediates (Gray, 1987). The BAS and BIS appear to map onto the left and right PFC, respectively (e.g., Davidson, Jackson, & Kalin, 2000) and integrate and provide a "read-out" from the lower level *motive* systems (Cacioppo, et al. 1999).

In addition, a third brain system, the Disinhibition/ Constraint system (DCS) provides a more general level (level three) of inhibitory control for the other systems (Watson & Clark, 1993). Inhibition acts to enforce selectivity among activated concepts by enhancing differential activation (see Nigg, 2000). Thus, DCS may govern the extent to which the system is motive-focused (resulting in enacting more motive-directed behavior) versus highly situationally reactive (resulting in an individual more prone to distraction).

Figure 1 shows the resulting three-level structure that is used in PAC. The activations of the motives are determined in part by situation factors and prior experience (i.e., knowledge and memory), but also by innate individual differences. The changing activation of individual motives is also affected by overall sensitivities set by the BIS and BAS. And, the entire activity of the system is further focused (or defocused) by the DCS.

Architecture and Implementation of PAC

The personality-based processes focus on the evolving social situation and on generating and applying strategies to achieve the various personal motives that are activated. Thus, there is an on-going social understanding process that recognizes situational affordances to pursue specific motivations. Whether that affordance results in an activation of the corresponding motivation depends largely on the person's baseline activation for that motive. For example, a person with a low baseline for pursuing dominance is less likely to recognize (or react to) situations that afford an opportunity to increase social status or dominance. The unfolding social situation and the person's response to it may also result in short term perturbations to activations of the various motivations, which, in turn, may temporarily change the behavior of the system.

The key component of the personality subsystem of PAC is the subsymbolic personality model, which integrates situational understanding with baseline activations of the general motives and the BIS/BAS/DCS sensitivities. The architecture of this component is discussed below, but we first discuss how knowledge is organized in PAC.

Knowledge as Story Structures

Knowledge is represented in an extensible set of generative story structures that are used to generate behavior and to interpret others' behavior. We did so, in part, because Miller and Read (1991) have argued that a simple story is fundamental to the representation of most traits. They (Miller & Read, 1991; Read, 1987) further argue that a story structure is central to how people represent their understanding of social interaction. Additionally, story structures provide a structured way for the developer of PAC-based IVAs to represent social knowledge.

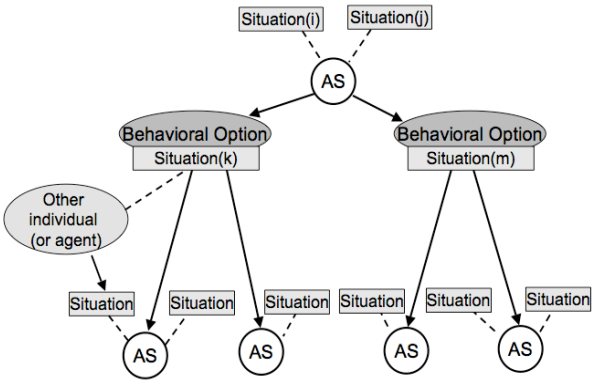

Fig. 2. Plot Units as Inherently Interactive Structures

The general representation of a story in PAC is as a collection of Plot Units, inspired by Lehnert (1981), which capture a piece of the story line and how it might play out. Each is composed of a series of interconnected Action Structures (See Figure 2). The 'Action Structure' forms a micro-level representation of an intended action in the causal-chronological sequence that makes up the Plot Unit. The Action Structure specifies such elements as the character/agent (WHO), the act-type (DOES-WHAT), the modality of action (HOW), and the setting (WHERE/WHEN). Perhaps most importantly, it also specifies the opportunities that different possible evolutions of the story afford for application of the overarching motives in the PAC personality model.

PAC is constantly monitoring its Situation Awareness: a set of specific knowledge elements and specific values for each agent; defining a state in which the external environment is perceived to be. Situational states are changed by the execution of Behavioral Options. PAC is looking to identify information that could indicate that another agent/actor has taken an action that either: a) moves some currently-underway story structure further along, or b) might begin a new story-structure. This is done by the Action Structure Matching process that tries to match possible other-agent behaviors (detected as changes in the situational awareness) with behaviors from action structures in its knowledge base of known Plot Units.

The Action Structure matcher identifies all possible Action Structures that would be consistent with the most recent changes in the Situation Awareness. This set of updated Active Narratives is then processed by the Narrative Selector, which selects the action structure that it will instantiate next along that narrative thread. The selection process is influenced by the specific set of motives that are active at the time, and their relative activation strengths. Thus, for example, if the agent has a high activation for the motive of seeking status, than an

action structure that affords more opportunity to achieve status might be favored over, say, another actions structure that would afford more opportunity to be helpful to others. This defines the current action instance, which will be processed in the rest of the current processing cycle.

Each Action Structure in each Story Structure may contain one or more motive implications – possible effects on the activation of specific motives as the Action Structure is executed. These Motive Implications are separately processed by the Motive Interpreter, which will update the activation of all motives to reflect their state at the end of the execution of this Action Structure. The Motive Interpreter (discussed in more detail below) also takes into account the existing motive activations, and the individual motive baselines and the baseline strengths of the BIS, BAS, and DCS.

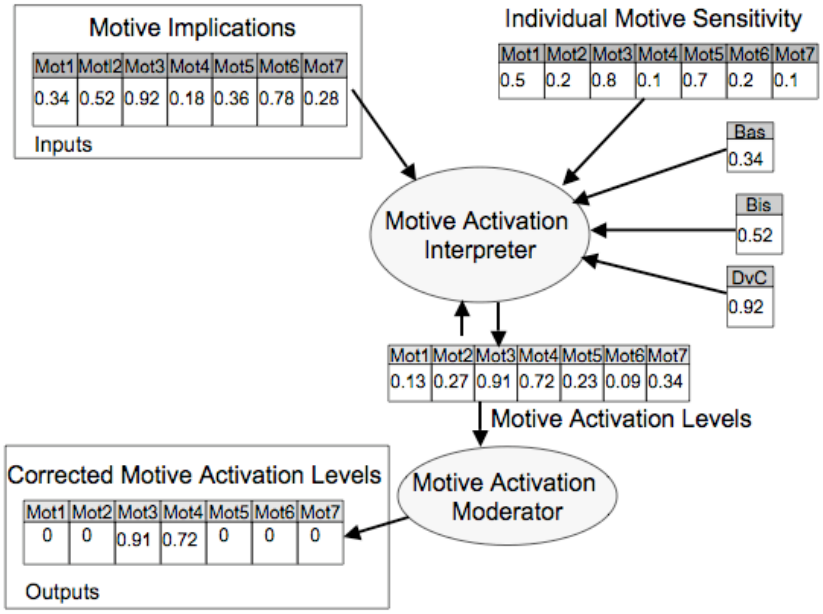

Fig. 3. PAC Motive Interpreter

Finally, the updated Motive Activations and selected Current Action Instance are used by the Behavior Selection process to identify the specific action strategy and set of behavioral options that will be taken as the result of executing the Current Action Instance.

The Plot Units (and the full stories) show all the expected evolutions of the story and are represented from the ego-centric view of the agent. Thus, for interactions to occur, there must be some general mapping of the plot units that are understood by the two actors.

Subsymbolic Personality Model

The story structures afford opportunities for PAC IVAs to exhibit specific personality traits or trait combinations. For example, a given part of the story may afford the opportunity for a strongly assertive person to exert leadership, but at the same time may afford opportunity for an insecure person to accept projected authority and be led. The subsymbolic personality mechanism within the PAC layer of the architecture controls the process by which inherent personality traits of the individual are exhibited. This model is described below. This component is termed the PAC Motive Interpreter (see Figure 3 for an example).

The Motive Interpreter calculates the motive activations for each motive as each Action Structure is processed during the evolution of a story. It operates on three types of data: (1) a set of *motive implications* from the current action structure – indicated by a value between 0 and 1 indicating the relevance of an action structure to a specific motive. For example in a pick up scenario in a bar, involving a man and a woman, each behavior of the man (such as offering the woman a drink) would have motive implications for each of the woman's motives. Thus, after the man takes an action, the Motive Interpreter would use these motive implications in the calculation of the woman's current motive activations. (2) a set of predefined individual motive *baseline activations* -- Each motive in PAC has a baseline activation that represents the innate tendency of the individual being simulated to pursue that motive when and if an opportunity arises. (3) three *sensitivity levels* associated with the BIS, BAS, and DCS.

For each motive, the motive interpreter calculates its level of activation R using one of two formulas. The first is used when a motive implication for this motive is provided by an action:

$$R = 1 - \frac{1}{1 + \gamma\left[I + S - DvC\right]_+} \quad (1)$$

Where: $[x]_+ = x$ if $x > 0$ and $[x]_+ = 0$ if $x <= 0$; I is the motive implication as provided by the current action structure, S is the individual sensitivity for this motive, *gamma* (γ) is either the BIS or BAS depending on the type of motive. Formula (1) adjusts the activation levels to meet the opportunities afforded in the current Action Structure.

The other formula is used when the current Action Structure has no motive implication for a particular motive. It implements decay that progressively returns the activation level to the individual sensitivity level:

$$R_n = k(S - R_{n-1}) + R_{n-1} \quad (2)$$

Where: R_n is the resulting level of activation of the motive for the n cycle and, R_{n-1} the activation level at the previous cycle, k is a decay parameter, and S is the individual baseline activation for this motive.

Once the new motive activations have been calculated, to capture the idea of competition and inhibition among the active motives for the control of behavior, the Motive

Interpreter sets the motive actions for all but the two most highly activated motives to 0. This insures that only the two most highly activated motives will play a role in the choice of behavior.

Selection of Actions and interpretations

PAC selects the next action or interpretation by calculating the scalar product of the absolute values of the motive implications (|**MotiveImplication**|) of each alternative action with the current motive activations and then selecting the action with the largest scalar product. (We use the absolute value because for this purpose it doesn't matter whether the action will facilitate or inhibit the achievement of a goal.) Using the scalar product allows all active m otives to influence the choice of an action and results in the selection of the behavior that has the combination of motive implications that is the most in line with the current combination of motive activations.

The notion that the choice of behavior is based on a multiplicative function of the Motive Implications and the current motive activations is consistent with recent characterization by Berridge (2004) of the nature of motivation. He argues, on the basis of a wide-ranging review of incentive concepts in the animal motivation literature, that the strength of "wanting" something, the motivation to take some action, is a multiplicative function of the incentive value of an action and the drive state of the organism. . One implication of this multiplicative function is that if either component is close to 0, so that the choice had little incentive value or the drive state was low, that the organism would not be motivated to choose that action.

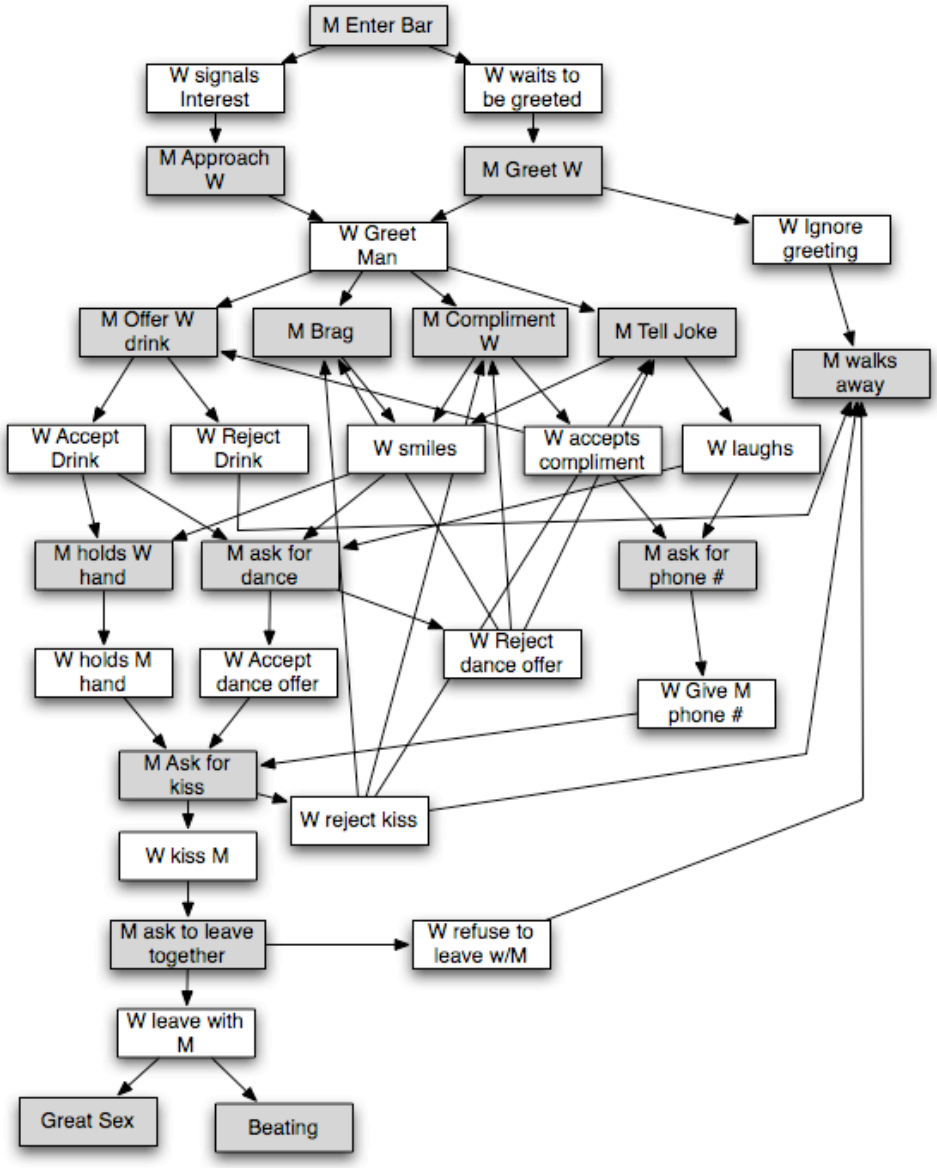

Figure 4: Dating Scenario

Dating Simulation in PAC

Initial brainstorming suggested that 'dating' scenarios might provide a rich scenario to test the role of PAC parameters in generating realistic personalities. BIG FIVE differences impact how individuals react to the behavior of others in pick-up situations (e.g., Cooperet al., 2007). A literature search helped us identify typical dating scenarios and how they might unfold. Because the most extensive literature on dating scenarios was in the domain of "pick-ups", that is the dating relationship upon which we focused. Based on the anthropological and psychological literature (Clark, Shaver, Abrahams, 1999; Ginsburg &Smith, 1993; Moore, 1985, 1998), research team members, and informants, the main scenario appears to consist of the following phases: (1) "*enter location* (e.g., bar) phase" (2) *attract attention* phase, (3) *approach* or *recognition* phase in which one secures interest by an attractive other, (4) *get to know* or *conversation* phase, (5) *touching* or *escalation* phase, and (6) *meet conditions for sexual intimacy* phase (e.g., establish plans, leave, meet-up again in private,).

There are also a fairly standard set of cues that can be used to de–escalate or end the interaction

(Moore, 1998). "Brush offs" can occur at any point. There are also many ways in which one or more of the actors may fail to achieve the "pick up" outcome in a given interaction. Therefore, the scenario could provide for a range of possible outcomes that could be dependent on the personality parameters of the agents.

Study 1: Sequential Probability Chunking.

To identify the main scenes in a typical dating/hook-up scenario we did the following. Based on previous research and their own experience the research team developed a list of 42 dating-related behaviors that might be observed in a bar setting. Study participants (N=18), 10 male, were given this list of behaviors. They were asked to group the behaviors into meaningful units of behavior (i.e., chunks).

Results. Using a minimum of 50% agreement (9 out of 18 raters) on the break point between subsequent behavior, six major chunks emerged. These were: (1) searching, (2) zeroing in, (3) getting to know each other, (4) testing the water, (5) escalation of intimacy, and (6) sealing the deal. These generally corresponded to the phases identified earlier by other researchers. The main story was tested and revised until the main story generated a number of distinct plausible alternative paths (see scenario in Figure 4).

Study 2: Identify motive implications of behaviors.

To determine the motive implications of actions in the scenario, the research team (7 individuals) first identified a set of motives (Achieve Physical/Sexual Intimacy, Achieve Social Interaction, Avoid Physical Harm, Avoid Social Rejection, Avoid Loss of Control) that we judged to be central to the dating scenario. We then rated each action for the extent to which it either inhibited or facilitated each of the woman's motives. Motive implications were rated only for the woman because here, the woman was an agent under program control, whereas the man's actions were chosen by a human from a list. The average ratings of the seven members of the team were input to PAC.

Personality parameter experiments.

We sampled the parameter space that yielded reasonable, human-like behavior by systematically manipulating the BIS, BAS, and individual motives. Our goal was to evaluate PAC's success in engineering broad classes of traits and their associated behaviors. The basic criterion used to evaluate success was whether we produced individual variability in behavior that correlated with underlying parameter settings.

In the first set of simulations we manipulated the BIS and the BAS values to determine what impact they would have on the sequence of actions. In these simulations, the woman's actions were chosen by the PAC program and the man's actions were chosen by a human from a list of possibilities. Table 1 presents 5 different sequences.

When BIS was 1 and BAS 10, the woman was more likely to engage in approach behaviors, for example kissing the man and going home with him. In contrast, when BIS was 10 and BAS was 1, the woman was more risk averse; she refused to dance and to kiss the man.

Table 1. Different Patterns of Behavior as a Function of the BIS and BAS settings

BIS	BAS	Physical/ Sexual Intimacy	Avoid Physical Harm	DvC	M enter bar, W signals interest, M approach W, W greet M…….. (common beginning followed by)
1	10	0.9	0.4	0.3	...M tell joke, W smiles at M, M ask for dance, W accepts dance, M ask kiss, W kiss M, M ask leave together, W leaves with M
					...M offer drink, W accepts drink, M holds W hand, W hold M hand, M ask for kiss, W kiss M, M ask to leave together, W leaves with M
10	1	0.9	0.4	0.3	...M tell joke, W smiles at M, M ask for dance, W refuse dance offer
					...M offer drink, W accept drink, M ask dance, W refuse dance offer
					….M offer drink, W accept drink, M holds W hand, W holds M hand, M ask for kiss, W refuse kiss

We then did a more targeted set of evaluations in which we manipulated the baseline activations of two motives of the woman (Physical/Sexual Intimacy and Avoid Physical Harm) (and also manipulated the BIS and the BAS slightly) (DCS was always set at 0.3) (See Table 2).

For the first woman, when BIS and BAS were equal and the Sexual Intimacy motive was higher, the woman tended to approach, ultimately going home with the man. However, for the second woman, when the motive values were reversed, now she tended to avoid: when asked to dance she refused. For the third woman, when the BAS is slightly lowered, she now laughs at the man's joke, instead of smiling, but ultimately refuses to dance with him. Finally, when the goals are reversed again, with Sexual Intimacy being .9, the woman does engage in many approach behaviors, but still ultimately refuses to leave. Compare this woman to the first woman, who has the same motives, but whose BAS is slightly higher and ultimately goes home with the man.

Table 2. Different Patterns of Behavior as a Function of Different Motive Settings

BIS	**BAS**	**Physical/ Sexual Intimacy**	**Avoid Physical Harm**	**Initial sequence of behavior for all: M enter bar, W signal interest, M approach W, W greet man, M tell joke….[followed by]**
7	7	0.9	0.3	**W smile M**, M ask dance, W accept dance, M ask kiss, W kiss M, M ask leave, **W leave with M**
7	7	0.3	0.9	**W smile M,** M ask dance, W refuse dance
7	5	0.3	0.9	**W laughs,** M ask dance, W refuse dance
7	5	0.9	0.3	**W smile M,** M ask dance, W accept dance, M ask kiss, W kiss M, M ask leave, **W refuse to leave**

Conclusions

These simulations demonstrate that PAC can be used to create agents with different personality characteristics, who make different choices as a function of differences in their underlying motivational system. This and other work we have done shows that it is possible to model human personality in terms of underlying motivational systems.

PAC is our initial attempt to help solve this problem. In pursuing this issue, we have come, or perhaps returned, to the simple notion that the social, motivational and emotional aspects are the fundamental characteristics on which human behavior (including purposive rationality) build. Accordingly, we have placed them at the core of IVA behavior generation, not at the periphery as so often has been done in the past. PAC is still in its early stages and is still evolving. Ultimately, we hope that its larger value is to promote the work on the critical and fundamental importance of personality, affect, and culture.

Acknowledgments: The research reported here was supported by the US Air Force Research Laboratory (ARFL) contract FA8650-04-C6439.

References

André, E., Rist, T., van Mulken, S., Klesen, M., & Baldes, S. (2000). The automated design of believable dialogues for animated presentation teams. In Cassell, J., Sullivan, J., Prevost, S., & Churchill, E.. (Eds.). *Embodied conversational agents*. Cambridge, MA: MIT Press.

Badler, N. I., Reich, B. D., & Weber, B. L. (1997). Towards personalities for animated agents with reactive and planning behaviors. In R. Trappl & P. Petta (Eds.). *Creating Personalities for Synthetic Actors: Towards Autonomous Personality Agents*. (p. 43-57). Berlin: Springer-Verlag.

Ball, G., & Breese, J. (2000). Emotion and Personality in a conversational agent. In Cassell, J., Sullivan, J., Prevost, S., & Churchill, E. (Eds.). *Embodied conversational agents*. (pp. 189-219). Cambridge, MA: MIT Press.

Bates, J. (1994). The role of emotion in believable characters. *Communications of the ACM*, *37*, 7.

Bates, J., Loyall, A., & Reilly W. (1992) Integrating Reactivity, Goals and Emotions in a Broad Agent. *Proceedings of the 14th Annual Conference of the Cognitive Science Society*, Indiana.

Berridge, K.C. (2004). Motivation concepts in behavioral neuroscience. *Physiology & Behavior 81* (2), 179 - 209.

Blumberg, B. (1994). Action-Selection in Hamsterdam: Lessons from Ethology. In D. Cliff, P. Husbands, J.A. Meyer, and S.W. Wilson, (Eds) *From Animals To Animats, Proceedings of the Third International Conference on the Simulation of Adaptive Behavior*, MIT Press, Cambridge Ma.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology*, 76, 839-855.

Clark, C. L., Shaver, P.R., Abrahams, M.F. (1999). Strategic Behaviors in Romantic Relationship Initiation. *Personality and Social Psychology Bulletin, 25,* 709-722.

Clark, L. A., & Watson, D. (1999). Temperament: A New Paradigm for Trait Psychology. In L. Pervin & O. John (Eds.). *Hndbk. of Personality: Theory and Research* (2nd ed.). NY: Guilford Press, pp. 399-423.

Cooper, M., O'Donnell, D., Caryl, P. G., Morrison, R., Bale, C. (2007). Chat-up Lines as male displays:

Effects of content, sex, and personality. *Personality and Individual Differences, 43(5)*, pp. 1075-1085.

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (Neo-PI-R) and NEO Five-Factor Inventory (NEO-FFI): *Professional manual*. Odessa, FL: Psychological Assessment Resources.

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion, Plasticity, Context, and Regulation: Perspectives from Affective Neuroscience. *Psychological Bulletin*, 126, 890-909.

Depue, R. A. (1996). A neurobiological framework for the structure of personality and emotion: Implications for personality disorders. In J. Clarkin & M. Lenzenweger (Eds.) *Major theories of personality disorders* (pp. 347-390). New York: Guilford Press.

Fiske, A. P. (1992). The four elementary forms of sociality: Framework for a unified theory of social relations. *Psychological Review*, 99, 689-723.

Ginsburg, G.P. and Smith, D.L. (1993). Exploration of the detectable structure of social episodes: The parsing of interaction specimens. *Ecological Psychology, 5, 195-233*.

Goldberg, A. (1997). IMPROV: A system for real-time animation of behavior-based interactive synthetic actors. In R. Trappl & P. Petta (Eds.). *Creating Personalities for Synthetic Actors: Towards Autonomous Personality Agents*. (p. 58-73). Berlin: Springer-Verlag.

Gratch, J. & Marsella, S. (2004). A Domain-independent framework for modeling emotion. *Journal of Cognitive Systems Research, 5(4)*, 269-306.

Gray, J. A. (1987). *The psychology of fear and stress*. (2nd Ed). New York: Cambridge University Press.

Kenrick, D. T., & Trost, M. R. (1997). Evolutionary approaches to relationships. In S. Duck (Ed.), *Handbook of personal relationships: Theory, research, and interventions* (pp. 151-177). Chichester, England: Wiley.

Lehnert, W. G. (1981). Plot units and summarization. *Cognitive Science*, *4*, 293-331.

Maes, P. (1990). How to do the right thing. *Connection Science Journal*, 1(3), 293-325.

McCrae, R. R., & John, O. P. (1992). An introduction to the Five-Factor Model and its applications. *Journal of Personality, 60*, 175-215.

Miller, L. C., & Read, S. J. (1991). On the coherence of mental models of persons and relationships: A knowledge structure approach. In G. J. O. Fletcher & F. Fincham (Eds.), *Cognition in Close Relationships*. (pp. 69-99). Hillsdale, NJ: Erlbaum.

Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological Review, 102*, 246-268.

Moffat, D. (1997). Personality parameters and programs. In R. Trappl & P. Petta (Eds.). *Creating Personalities for Synthetic Actors: Towards Autonomous Personality Agents*. (p. 120-165). Berlin: Springer-Verlag.

Moore, M. M. (1985). Nonverbal Courtship Patterns in Women: Context and consequences**.** *Ethology & Sociobiology. Vol 6(4), 237-247*.

Moore, M.M. (1998). Nonverbal courtship patterns in women: Rejection signaling – An empirical investigation. *Semiotica 118-3/4*, 201-214.

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: Views from cognitive and personality psychology and a working inhibition taxonomy. *Psych. Bulletin*, *126*, 220-246.

Panksepp, J. (2000). Emotions as natural kinds in the mammalian brain. In M. Lewis & J. M. Haviland-Jones (Ed.), *Handbook of Emotions (2nd edition)*. (pp. 137-156). New York: Guilford Press.

Pickering, A. D., & Gray, J. A. (1999). The Neuroscience of Personality. In L. Pervin & O. John (Eds.). *Hndbk. of Personality: Theory and Research* (2nd ed.). NY:Guilford Press, pp.277-299.

Read, S. J., & Miller, L. C. (1989). Inter-personalism: Toward a goal-based theory of persons in relationships. In L. Pervin (Ed.), *Goal concepts in personality and social psychology* (pp. 413-472). Hillsdale, NJ: Erlbaum.

Read, S.J., Miller, L. C., Monroe, B., Brownstein, A., Zachary, W., LeMentec, J. C., & Iordanov, V. (2006b) A Neurobiologically Inspired Model of Personality. In J. Gratch et al. (Eds.), *Intelligent Virtual Agents 2006,* Lecture Notes in Artificial Intelligence, 4133. Berlin: Springer-Verlag.

Read, S.J., Miller, L.S., Rosoff, A., Eilbert, J., Iordanov, V., LeMentec, J.-C., and Zachary, W. (2006a) Integrating Emotional Dynamics into the PAC Cognitive Architecture. In *Proceedings of the 15th Annual Conference on Behavioral Representation in Modeling and Simulation*, Orlando, FL: Institute for Simulation and Training.

Saucier, G., & Goldberg, L. R. (1996a). Evidence for the Big Five in analyses of familiar English personality adjectives. *European Journal of Personality*, 10, 61-77.

Tellegen, A., & Waller, N. G. (1997). Exploring personality through test construction: Development of the Multidimensional Personality Questionnaire. In S. R. Briggs, J. M. Cheek, & E. M. Donohue (Eds.), *Handbook of adult personality inventories*. New York: Plenum Press.

Watson, D., & Clark, L. A. (1993). Behavioral disinhibition versus constraint: A dispositional perspective. In D. M. Wegner & J. W. Pennebaker (Eds.), *Handbook of mental control*. (pp. 506-527). Upper Saddle River, NJ: Prentice Hall.

Zachary, W., LeMentec, J-C., Miller, L. C., Read, S. J., & Thomas-Meyers, G. (2005). Steps toward a Personality-based Architecture for Cognition. In Proceedings of the 14th Annual Conference on Behavioral Representation in Modeling and Simulation. Orlando, FL: Institute for Simulation and Training.