Fight the Way You Train: The Role and Limits of Emotions in Training for Combat

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EMOTIONS PLAY A POWERFUL ROLE in our lives and not surprisingly, they play an equally central role in military planning and training. Emotions shape how we perceive the world, bias our beliefs influence, our decisions and, in large measure, guide how we adapt our behavior to the physical and social environment. Although advances in psychology and neurophysiology have highlighted the rational and adaptive nature of some emotional responses, emotions can be influenced and exploited as a social tool.[1] This is the essence of their value to military operations. The ancient Greeks wrote about the rhetorical power of *pathos*, an appeal to emotion, military planners throughout history have incorporated an emotional element into their military doctrine. Machiavelli wrote that in order to motivate citizens to withstand a long siege, one should encourage "fear of the cruelty of the enemy." The more modern strategy of "Shock and Awe" relies just as explicitly on an appeal to emotion.[2] The U.S. Army leadership manuals illustrate the role of emotion in operational terms:

> Commanders, while shielding their own troops from stress, should attempt to promote terror and disintegration in the opposing force. … Some examples of stress-creating actions are attacks on his command structure; the use of artillery, air delivered weapons, smoke; deception; psychological warfare; and the use of special operations forces. Such stress-creating actions can hasten the destruction of the enemy's capability for combat.[3]

The leadership manual goes on to state ominously that "failure to consider the human

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factors in an environment of increased lethality and uncertainty could cause a nation's concept of warfare to be irrelevant."[4]

With such explicit proscriptions, it is potentially troubling that emotions and other psychological factors are so poorly modeled by the computer simulations that increasingly inform and shape military operations. Nevertheless, several trends have contributed to the military's growing reliance on simulation technology. Military training is dangerous and increased concern for human life pressures trainers to find alternatives to live exercises. Military equipment is complex and expensive to operate, and military operations increasingly rely on tightly integrated "systems"—joint operations or networked fires—where it is difficult to train one capability in isolation from other elements in the system. There is also a growing desire to use simulation as a form of rapid prototyping to reduce acquisition costs, allowing planners to experiment with different design requirements before ever building a physical system. Finally, advances in artificial intelligence and computer technology have raised expectations and facilitated more ambitious projects, including attempts at modeling not just the physical properties of weapons platforms, but also the cognitive properties of battlefield decision makers.[5] Collectively, these trends have compelled military trainers and planners to rely on computer models to simulate the behavior of some or most battlefield units, whether it is for training some aspect of an integrated system or for exploring new tactics and weapon platforms. As simulations aspire to capture not merely the physics of weapon platforms but also the psychology of the individuals that command them, it is worth considering how well these simulations capture the "human factors" that underlie military operations.

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The acknowledged weakness of simulation technology is its failure to capture the essence of human behavior.[6] The field of artificial intelligence has made great strides in producing algorithms that plan, act and learn from experience. These techniques however have grown out of a narrowly rational conception of intelligent behavior. Contemporary artificial intelligence approaches arose from normative perspectives on intelligence, such as decision theory, logical deduction, and game theory. Although rationality seems a reasonable goal for the engineering applications that have motivated artificial intelligence, these models currently have significant shortcomings when it comes to modeling human behavior. In contrast, cognitive modeling approaches that explicitly capture human capabilities and limitations have tended to focus on narrow scientific phenomena—explaining reaction time data or the impact of priming on recall tasks—and are less appropriate for modeling the broad reasoning capabilities demanded by modeling and simulation applications. The consequence is that modeling and simulation systems are particularly ill-suited for capturing the influence that factors such as stress and emotion can have on military outcomes. This puts such systems at a risk of implicitly institutionalizing a misleading view of human behavior—a view that increasingly shapes military training, planning, and acquisition decisions.

In this article, we illustrate how military simulations fail to account for the impact that emotions have on military operations and the consequences of this failure for military decision making. Although we believe that this has important implications for all aspects of military thinking, we will focus on the question of training: how might inaccurate emotional models impact the lessons soldiers draw from their training simulations? And how technology developers are attempting to address these issues. We discuss our current work to increase the behavioral realism of such models and conclude with some general reflections on the limits of socio-emotional reasoning and the challenges this type of reasoning poses for a nation's concept of warfare.

Emotions and Negative Training

Imperfect models of human emotional behavior can produce *negative training*. Negative training occurs when the user's performance after training is actually lower than they would have without training. Education experts have long understood that negative training can arise in simulated training environments due to subtle discrepancies between simulated reality and the real world. This effect is not limited to computer simulations, but any training situation that differs from the final operational context. This is the motivation behind the military's training motto "train the way you fight" but one is rarely able to completely mimic reality during training. For instance, the subtle limits in flight dynamics models that underlie aircraft simulators can lead to increased accident rates in battle.[7] Even measures intended to improve safety can lead to negative training. When soldiers in the U.S. Army's Third Infantry Division performed live-fire training for urban combat in Iraq, they were required to point their weapons to the ground except when actually shooting, whereas in actual combat they should instinctively point their weapons up towards the rooftops.[8] Thus, there is the potential that a seemingly benign safety measure can produce bad habits that put soldiers at greater overall risk.

Absent or overly simplistic models of human emotion and motivation can similarly result in negative training if users lose sight of these technological limitations. Simple models of human behavior can be more than adequate for understanding the physical impact of tactics and weapon's platforms, but they can be wholly inappropriate for evaluating tactics with a strong psychological component, such as "Shock and Awe." In the best case, the users will recognize these limits and carefully circumscribe their conclusions. It is far too easy, however, to over generalize from simulated outcomes, particularly given the tight and subtle connection between psychological factors and operational outcomes.

With inaccurate models, some strategies and tactics may appear too effective, leading one to become overconfident in their likelihood of success. For example, some simulation techniques attempt to model unit morale in terms of objective factors such as force ratios (e.g. a vastly outnumbered force will be more inclined to retreat or surrender). Such models, however, can overlook the numerous and individually varying psychological factors that impact individual and group morale. For instance, strong belief in the justice of one's cause can motivate a tenacious and angry defense in the face of overwhelming odds. In the Battle of Marathon, the Athenians dramatically defeated a much larger Persian army, killing over six thousand Persians while receiving only 150 casualties. Herodotus explained the outcome in emotional terms, "liberty and equality of civic rights are brave spirit stirring things, and they who, while under the yoke of a despot, had been no better men of war than any of their neighbors, as soon as they were free, became the foremost men of all."

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In contrast to strategies that appear overly effective, some strategies and tactics may appear unsuccessful without accurate models of human emotion and motivation, leading one to abandon or discount very efficient strategies. A key example here is the use of suppressive fire. Before the age of precision weapons, an unquestioned tactic was the use of large quantities of "dumb" weapons to blanket an enemy position with the goal, not to permanently destroy their fighting capability, but to temporarily promote terror and disorganization so that friendly forces could advance on or safely bypass their position. The effectiveness of suppressive fire presumes a psychological effect: enemy units will be less effective due to individual fear or contagious panic than might be predicted from a purely rational analysis of the costs and benefits of maintaining their defensive posture. Unfortunately, trends in military training have lead units to undervalue this psychological effect. An internal assessment of artillery training concludes that training techniques "condition" military decision makers to undervalue the effectiveness of suppressive fire, even going so far as to argue that Hollywood-style pyrotechnics should be added to artillery live-fire exercises to increase soldiers understanding of its impact.[9]

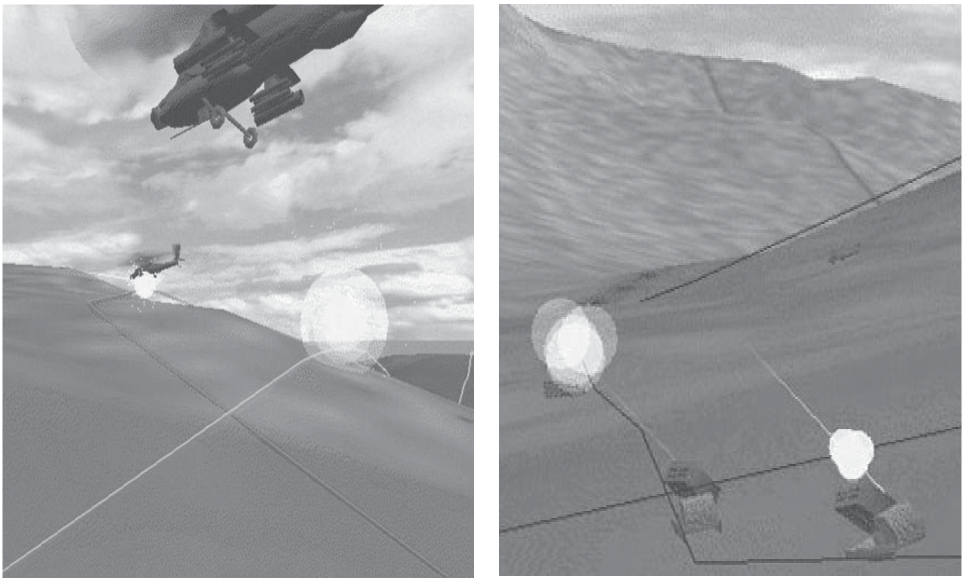

Figure 1: Simulated Apache helicopters crossing the forward line of enemy troops with the aid of suppressive fire from multiple launch rocket systems in ModSAF.

Emotion and Suppressive Fire

An example from our work on large scale military training simulations illustrates how a lack of emotional modeling can contribute to an unrealistic estimate of the effectiveness of suppressive fire. We were involved in an effort to model Apache helicopter battalions in a large entity-based simulation system called ModSAF (entity-based systems individually model every unit that participates on the battlefield rather than treating a collection of units as a single entity). Apaches are designed to attack behind enemy lines and a standard tactic is to call for suppressive fire whenever moving past front-line enemy units (see *Figure 1*). The problem was that ModSAF did not attempt to model the psychological impact of suppression. In contrast to being rendered temporally ineffective by the Apache fire, ground units transitioned into a defensive mode, with the result that they were actually more effective in shooting down inbound Apaches than if no suppressive fire was used. To achieve a "more realistic" operational result, we adjusted unit tactics to avoid the use of suppressive fire, relying instead solely on precision weapons such as Hellfire missiles whenever engaging enemy units. The lesson from our ModSAF experience is that a small defect in behavioral models–in this case how ground units respond to suppressive fire–could cause a whole cascade of subtle effects due to the tight interconnected nature of modern military operations. An ill-informed observer of the simulated exercise might draw a host of unjustified conclu

Figure 2: Jonathan Gratch interacting with the Mission Rehearsal Exercise system

sions: that suppressive artillery fire is ineffective for Apache missions, that Apache's don't need to tightly coordinate with artillery units, that artillery units do not have to devote ammunition to Apache missions, that logistic units do not need to re-supply artillery units as frequently, that smaller logistics trains are required to support aviation missions, etc.

Emotion and Leadership Training

If such systematic problems arise when modeling large collections of ground units, imagine the complexities of modeling the highly varied emotional behavior that arises in face-to-face interpersonal interactions. As military operations have shifted towards small groups and closer connections with civilians and the media, military trainers are increasingly interested in training simulations that emphasize interpersonal training. Even seemingly mundane interactions, such as a traffic accident between a civilian and military vehicle, can unravel an operation. To function effectively and avoid misunderstandings that could have unintended consequences, it is important that soldiers understand the customs, norms, habits, and taboos of the local population and they need to be exposed to the thorny dilemmas and decisions that may await them.

Our more recent work on the Mission Rehearsal Exercise system (MRE) is designed to provide that kind of experience in simulation, before trainees encounter it in reality.[9] While most military simulations involve simulating airplanes or tanks, MRE puts trainees into unscripted human-oriented simulations, where they can improvise solutions with *virtual humans* (see *Figure 2*).[10] These software entities look and act like people and can engage in conversation and collaborative tasks, but unlike robots, they live in simulated environments. The technology underlying virtual humans is a natural, albeit more ambitious extension of the approaches used to model human decision-makers in military simulations.[11] It requires a multidisciplinary effort, joining traditional artificial intelligence problems with a range of issues from computer graphics to social science. Programming virtual humans to act and react in their simulated environment draws on the disciplines of automated reasoning and planning. To hold a conversation with a virtual human, programmers must exploit the full gamut of natural language research, from speech recognition and natural language understanding to natural language generation and speech synthesis. Providing human bodies that can be controlled in real time delves into computer graphics and animation. Yet when virtual humans look like real humans, people will expect the simulated graphic to behave like real humans and will be disturbed by, or misinterpret, discrepancies from human norms. Thus, virtual human research must draw heavily on psychology and communication theory in order to appropriately convey nonverbal behavior, emotion, and personality.

In our current prototype, a lieutenant-in-training commands a platoon of soldiers in the context of a Bosnian peacekeeping mission. In the midst of a mission to support a weapons inspection, the trainee's platoon becomes involved in an accident with a civilian and he or she must learn how to balance the competing demands of this emotionally charged situation. A small boy is on the ground with serious injuries, his mother is frantic, and a crowd is starting to form. A TV camera crew shows up and begins taping. What should the lieutenant do? Stop and render aid? Continue on with the mission? What the student decides will affect the rest of the exercise.

From the perspective of this article, a key challenge in creating such scenarios is capturing the emotional dynamics of the people involved. How do we simulate a frantic mother and the ways she might react to the trainee's decisions, and, in turn, how might the behaviors of synthetic characters shape and influence the trainee and impact the lessons learned?

MODELING EMOTION

To model emotion in simulation, we need to consider what emotion is, how it impacts human behavior and how it can be modeled within a simulation environment. To understand emotion and its impact on behavior, we turn to the neural sciences and psychology. Utilizing an uncomplicated view, emotions can be viewed and studied as simple patterned behavioral and physiological responses to specific stimuli. Neural and psychological research however, has increasingly argued that emotion is more than simple patterned response and in fact that there is a tight integration of emotion and cognitive processes. For example, Damasio, coming from a neural anatomy perspective, argues that emotion plays a central role in cognition and particular decision-making.[12] Coming out of psychological research, cognitive appraisal theories of emotion demonstrate how emotions can arise from a cognitive assessment of the environment and how that assessment and in turn influences behavior.[13]

Utilizing an uncomplicated view, emotions can be viewed and studied as simple patterned behavioral and physiological responses to specific stimuli.

Cognitive appraisal has had a major impact on psychological research in emotion and is the foundation of our computational models. In appraisal theories, emotions are part of an adaptive, flexible set of responses to the environment. This flexible response is realized by two basic processes: appraisal and coping.[14] Appraisal generates emotion by a cognitive assessment of the person-environment relationship along several key dimensions, including whether an event facilitated or inhibited the person's goals, how critical the impact of this event was and who deserves blame or credit.

Coping is the process by which people deal with emotions. Two classes of coping have been identified; problem-focused coping and emotion-focused coping. Problem-focused coping acts externally on the world to address the factors leading to an emotional reaction. For example, if some event threatens a person's goals, leading to anger, the person may take action to counter that threat. Emotion-focused coping acts internally to change beliefs or attention. A person, for example, may deny a threat is real, resign themselves to the fact that the threatened goal cannot be achieved, or in some way try to avoid thinking about the threat. Within these broad classes of coping, people manage emotions in myriad ways and psychologists have documented a rich set of strategies. Different individuals tend to adopt stable and characteristic "coping styles" that are correlated with personality. Furthermore, coping and appraisal interact and unfold over time, leading to dynamic and characteristic changes in emotional state that has been noted by several emotion researchers: a person may "feel" distress for an event (appraisal), which motivates the shifting of blame (coping), which leads to anger (re-appraisal).[15]

Realizing emotions in simulations

In order to make cognitive appraisal amenable for use in simulation environments, it needs to be re-cast as a computational model. To do this, we have tied appraisals and coping to an explicit representation of a virtual human's beliefs, goals and plans, and their relationship to past, present, and future events. This representation, which we call the causal interpretation, encodes the psychological concept of a person-environment relationship. It has several advantages for modeling emotion. It facilitates reasoning about blame and indirect consequences of action (e.g. a threat to a sub-goal might be distressing, not because the sub-goal is intrinsically important, but because it facilitates a larger goal). It provides a uniform representation of past and future actions (this action caused a disturbing effect which I intend to deal with in the future). It also facilitates reasoning from other perspectives—I think this outcome is good but I believe you think it is bad.

Coping operates on the agent's beliefs, goals and plans, but in reverse to appraisal strategies.

Our approach to appraisal assesses the person-environment relationship via features of the causal interpretation.[16] Speaking loosely, we treat appraisal as a set of feature detectors that characterize the consequences of an event from the virtual human's perspective. These variables include the desirability of those consequences, the likelihood of them occurring, who deserves credit or blame, and a measure of the ability to alter those consequences. For example, a threat to a unit's mission is undesirable, whereas its failure to achieve an objective might be blamed on its own mistakes or the unreasonableness of its orders. The result of this feature detection is one or more appraisal frames, which characterize the virtual human's emotional reactions to an event. Thus, the belief that another agent (human or virtual human) has caused an undesirable outcome leads to distress and possibly anger.

Our computational model of coping similarly exploits the causal interpretation to uncover what features led to the appraised emotion, and what potential there may be for altering these features.[17] In essence, coping is the inverse of appraisal. To discharge a strong emotion about some situation, one obvious strategy is to change one or more of the factors that contributed to the emotion. Coping strategies operate on the agent's beliefs, goals and plans, but in reverse of appraisal strategies. Copping seeks to make a change, directly or indirectly, that would have the desired impact on appraisal. Coping could impact the agent's beliefs about the situation, such as the importance of a threatened goal, the likelihood of the threat, responsibility for the threat, etc. For example, a unit that is losing badly might cope by denying the reality of its setbacks. Further, the agent might form intentions to change external factors, for example, by performing some action that removes the threat. Indeed, our coping strategies can involve a combination of such approaches. This mirrors how coping processes are understood to operate in human behavior whereby people may employ a mix of problem-focused coping and emotion-focused coping to deal with stress.

To perform in the virtual environment, the virtual human must understand and generate speech, generate and repair plans and direct its sensors to perceive activities in the environment. All of these operations reference or modify the virtual human's interpretation of past, present, or future. Perception updates beliefs, for example. Each time one of these operations accesses an element of the causal interpretation, it activates any appraisals associated with the element. These emotions associated with the object are made available as "concerns" for the coping process which in turn, through emotion and problem focused coping strategies, may lead to additional changes in the interpretation. Thus, through the causal interpretation, the virtual human's "cognitive" and "emotional" processes are tightly coupled.

Whereas there has been prior work in computational models of appraisal, there has been little prior work in modeling the ways that people cope with emotions. And yet coping behavior is a key aspect of human behavior. Our work is building a library of these coping strategies and uses personality-inspired preference rules to model consistent differences in style across different virtual humans. Our virtual humans may take preemptive action to circumvent a stressful factor, they may choose to shift blame to another agent or they may behaviorally disengage from attempts to achieve a goal that is being thwarted or threatened.

THE COMPLEXITY OF EMOTIONAL PROCESSING

Appraisal theory argues that emotion can be far more than a simple stimulus-response gut reaction. Rather, cognitive processes appraise events, and draw inferences on the event's significance and evaluate possible coping responses. Appraisal may rely on very little concrete evidence but draws on considerable inferential processes. The frantic mother is a prime example. Our virtual mother reacts aggressively when she sees troops leaving, inferring that they are abandoning her and her son. This behavior is unrealistic considering that prior to this, when the other agents in large measure ignored her, she was not disturbed. A real mother would likely respond quite differently if she were worried that the soldiers were not going to help her and her son. It is reasonable to expect a real mother to become increasingly agitated and aggressive in her attempts to get the lieutenant's attention prior to the signaled departure of the troops. This first became evident in an improvisation session with human actors playing these roles. The actor playing the mother, when ignored, would grab the lieutenant's attention and the actors playing soldiers would respond with increasingly aggressive attempts to control the mother. In short, the improvisation quickly spiraled out of control. Examples of such interactions play out in real life, in both mundane settings as customers in a store feeling ignored as well as life-threatening war-time settings.

Appraisal and the inferential processes it relies on, will also be influenced by, the individual's prior experiences, attitudes, beliefs, and personal, social, or cultural factors. These factors can heavily influence interpretation of events. Again, consider how a real mother might respond in our accident scenario. Prior beliefs or attitudes about the soldiers will influence the mother's appraisal. She may attribute the presence of the soldiers in her country to a foreign nation's selfish reasons and be less willing to believe that the soldiers seek to help her and her son, which again would fuel anger.

It is also important to consider the influences of the immediate social context of an event. In the example of the mother, if the mother infers that the medic is extremely worried about her son, it would impact her appraisal of the severity of her son's condition and increase her anxiety. This process whereby "one person uses another person's interpretation of the situation to formulate her own interpretation of it" is called social referencing.[18] Related to social referencing is the notion of emotional contagion, a process whereby a person's emotional state is influenced by the emotional states of others around them. If a local crowd gathered and angrily blamed the soldiers for the accident, it may well influence the mother's emotional state directly or via her assessment of the situation.

As these examples illustrate, one of the fundamental insights to be drawn from appraisal and the study of emotion is that emotion can evolve from subtle, complex, and biased influences. Therefore, the behaviors that it motivates are not so easily predicted or controlled. This is, in part, a consequence of the central role of cognitive processes.

Conclusion

Throughout history, a key aspect of military operations has been the manipulation of the enemies' emotions. Over two and a half millennia ago, Sun Tzu wrote that "one need not destroy one's enemy. One need only destroy his willingness to engage." Perhaps the most lurid practitioner of such manipulation was Vlad Tepes—Vlad the

Impaler— who in the 15th century reportedly impaled twenty thousand men, women, and children in a field in order to scare off an invasion. Such blunt manipulation of primal emotions is a forceful way to achieve compliance. Recognizing this type of threat involves little inference and leaves on limited space for personal and cultural factors to bias the appraisal process.

Short of such explicit attempts at forced compliance, the picture is more complex. Far more subtle factors are at play in peacekeeping missions like the MRE or combat missions. These missions emphasize a large psychological component, which military planners increasingly seem to favor. In winning the hearts of a populace, achieving the desired emotions and attitudes are less primal and achieving them requires a subtle influence—forced compliance will not work. Arguably, subtle techniques are more prone to appraisal biases and will lead to less predictable outcomes. Prediction is further complicated in the modern information age by the need to consider the responses of multiple parties on multiple sides of the conflict—recall the cameraman in our MRE scenario. Finally, it is often the case that emotions are often not simply a means to the end, as they may have been for Vlad; rather, today the intent is to realize a longer lasting not simply momentary compliance. Emotions therefore, become important for more than strategic purposes, they become part of the military objectives.

Appraisal theory provides a relatively economical description of emotional processes.The same, however, cannot be said about the impact of these processes on behavior. Appraisal theory is not a prescriptive model. It does not provide a unique answer to whether a military tactic will succeed. What appraisal theory can do is to make explicit the factors that underlie emotional judgments. It can provide some means for systematically varying these factors, and, hopefully, guard against overconfidence in the outcome of any particular simulation run. Human emotional behavior is highly dependent on by individual, social and historical factors that come into play when an individual appraises his environment. Appraisal relies on powerful but flawed inferential processes. In developing our models we have felt the increasing need to faithfully represent these factors. Our hope is that the emotional reactions of our virtual mother come to be equal in intensity and content to those of a real, distraught mother.

Notes

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