EMOTION, INTENTION AND THE CONTROL ARCHITECTURE OF ADAPTIVELY COMPETENT INFORMATION PROCESSING

Carl B. Frankel [1] Rebecca D. Ray [2]
[1] Organizational Measurement & Engineering, San Francisco, CA, USA
[2] San Francisco State University, San Francisco, CA, USA
[1] carlf@ome1.com [2] rray@sfsu.edu

ABSTRACT

Emotionally governed, expectancy biased adaptive control is a suitable, non-conscious control architecture for the intentional processes of mind. The argument is as follows: (a) A control architecture for competent processing, expectancy biased adaptive control, is exposed. This architecture is a credible result of natural selection, and exhibits weak and strong intention. (b) The empirical literature on emotion is reviewed in terms of the expectancy biased adaptive control architecture, to argue that emotions are control signals that appraise circumstances' urgency, category, harm, benefit and uncertainty, in order to interrupt activities, regulate goal selection and modulate rate of settling. (c) The bridging concept of motivation is introduced to argue that, as control signals with the causal force to govern orderly processing in response to change, emotions supply the motive force to effect the content of intentions. (d) Reflectively conscious volition, one source of intentions but also a slow, encumbering and thus not the primary source of intentions, is one of many competing sources of demands impinging upon and resolved by the emotionally governed control system.

1 Ontology of Intention

Suppose a robot is built that knows how to secure and to use materials to replicate itself. Suppose further that one of the necessary materials is gold. The robot locates a goldmine and starts removing and smelting gold. In response, the mine's owners place barriers and hazards that the robots—many now—learn to overcome. So far, the robots are behaving like sophisticated ants. Suppose, however, that the robots start to attend to the *people* placing the obstacles. Being adaptable robots with highly resolved sensors and fast processors, they start to correlate and parse the actions that signal peoples' future actions—and peoples' deceptive falsification of signals (Ekman, 1991)—in real-time as peoples' intentions are forming, well before people know their own intentions. The robots thereby pre-empt peoples' hostile actions. Further, the same human abilities and patterns of approach and avoidance that correlate with the mine owners placing obstacles are recognized by the robots to make the owners adept and controllable miners—after all, dogs herd sheep and even some ants herd and husband aphids for the excreted sugars. The mine owners become enslaved.

These robots are like sophisticated dogs, having neither reflective consciousness nor the capacity for natural language. The robots adapt to humans' behavior, including signaling productions, in a stimulus-response, Chinese room way—that is, forming what Searle (1997) calls regulative ascription of correlation and causality rather than ascription or constitutive assignment of function. As drawn, the robots are consistent with Searle's (1992) assertion—and psychological data—that reflective consciousness is distinct from motor activity.

Yet these robots do not conform to Searle's ontological binding in which the contents of intention are inherently the product of reflective consciousness. Without reflective consciousness, the robots are displaying weak, strong and intrinsic intention (Dennett, 1996). The robots exhibit the syntax of purposiveness (weak intention), in that the content of the robots behavior is to persist in pursuing a constant outcome across varied situations using progressively efficient means. Indeed, without forming a theory of the miners' minds, the robots exhibit autonomous real-time recognition of and co-adaptation with the co-adapting intentions of others. The robots are also exhibiting the semantics of aboutness (strong intention), in that their local, gold-acquiring activity is in the service of a global goal, the content of which is to self-replicate. Finally, even if the intent to self-replicate was initially extrinsic, deriving from the robots' creators, the robots' intent is now intrinsic, since the content of creators' intentions does not include that the robots enslave people like miners to extract gold—or enslave robot makers to enhance the robots' capabilities. Each robot has an intentional, motivated mind in relation to the minds around it, as surely as a pet dog has an intentional mind in pursuit and defense of a tummy-scratch, a bone, a mate or its puppies. These robots, like pet dogs, are intentional but not reflectively conscious.

This paper presents an architecture for the intentional underpinnings of mind. The intentional contents of mind are not inherently a product of reflective, volitional consciousness but rather are any contents that become embodied in and effected by *emotional* control signals. Emotional control, and the intentional contents that emotions effect, are predominantly automatic and only sometimes influenced by conscious volition.

The argument is made in four broad strokes. (*a*) A control architecture for competent processing, expectancy biased adaptive control, is exposed. This architecture is a credible result of natural selection, and exhibits weak and strong intention. (*b*) The empirical literature on emotion is reviewed in terms of the expectancy biased adaptive control architecture, to show that emotions can credibly be conceptualized to be those control signals that appraise changing circumstances and regulate response. (*c*) The bridging concept of motivation is introduced, in order to argue that intrinsic intention and the intrinsic component of all motivation are subsumed in a single ontological category. As control signals with the causal force to govern orderly processing in response to change, *emotions supply the motive force to effect the content of intentions.* (*d*) Reflective consciousness is not needed in an architecture in which emotions motivate the realization of intentions. To the contrary, reflective processes can be slow enough as to maladaptively undermine responsiveness, were the deployment of consciousness not at the service of the control architecture. Conscious volition is one of many competing sources of demands to be resolved by the emotionally governed control system.

Emotionally governed, expectancy biased adaptive control is thus a suitable, non-conscious control architecture for the intentional processes of mind.

2 Adaptation to Stochastic Change

Independent of any role for emotion, adaptive (feedforward) control is a self-regulatory architecture that is credible to be favored by natural selection, because adaptive control competently regulates the pressures of stochastically varying circumstances in order to achieve a global goal adequately. In so doing, adaptive control exhibits strong, though not necessarily intrinsic intention. Adaptive control exhibits the co-adaptive syntax of weak intention since, with respect to immediate (local) goals, an adaptive controller can exhibit persistence of goal achievement by efficient means in varying circumstances. Adaptive control also exhibits the goal-directed semantic aboutness of strong intention, since the immediate goals of behavior occur in the service of—and thus are about—a global goal to avoid harm and to attain benefit.

2.1 The Stochastics of Competence

As basic terms, 'adaptive competence', 'information processing', 'control signal', and 'self-regulation' need definition. All four are defined in terms of a common construct, 'stochastic variation'.

One predicate for adaptive competence is a context of sufficient regularity to which to adapt. The least restrictive assumption of regularity is that the context exhibits *stochastic variation,* that is, random variation bounded by a probability distribution. If unbounded random variation is permitted, then regularity, form, order, discernible meaning and adaptation are not possible.

Adaptive competence occurs when ordered, regular and meaningfully patterned relations—standards of competence—are maintained in relation to some stochastically varying context, despite the stochastic pressure of irregularity and disorder that increases error and degrades order and discernible meaning. Adaptively competent management of stochastic variation is the problem to be solved.

Adaptive competence is an *information processing* problem, since information theory characterizes order (redundancy), and how order is preserved during processing and transmission, despite systematic, stochastic and random variation (entropy) that would degrade order. Information processing is a functional description of what an adaptively competent entity must do to manage stochastic variation.

Control signals are those which cause processing to occur at the time that it occurs. In any information processing architecture, competent control manages stochastic variation by causing correct processing to occur at a correct time or in a correct sequence.

Self-regulation names a class of information processing architectures that accomplish goals and standards (*e.g.,* standards of competence) by iterative approximation, that is, by iterative reduction of error, typically in operating environments that exhibit continuous stochastic variation. A self-regulatory architecture is therefore a natural candidate for adaptively competent information processing.

2.2 Criteria for Adaptively Competent Information Processing

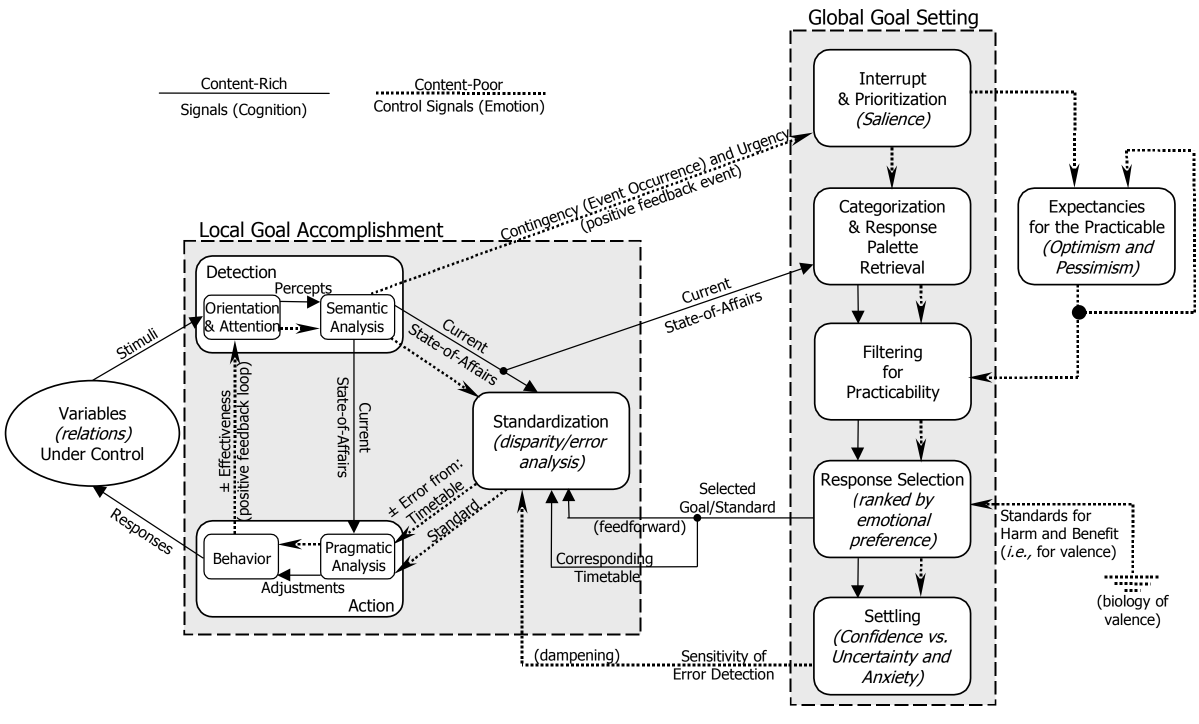
Given that the problem of adaptive competence is to avoid error in the face of stochastically varying circumstances and demands, several criteria are posited that an architecture must satisfy to solve the problem of competence. The greater the stochastic pressure, *i.e.,* the lower the determinism and the greater the typical rate and direction of change, the more stringent are the criteria.

2.2.1 Adequate Correctness

Even modest stochastic pressure levies two fundament requirements for basic correctness. *Efficacy:* To avoid behavior that is random with respect to goals, each individual must form and utilize appraisals of the harms and benefits with respect to goals, and her or his efficacy with respect to avoiding harms and attaining benefits. *Synchronization:* To avoid untimely behavior, each individual must maintain adequate synchronization with circumstances, recognizing changing contingencies, and delivering responses at circumstances' rate of change.

2.2.2 Adequate Efficiency of Resource Utilization

As stochastic pressure increases, an individual not only must exhibit basic efficacy and synchronization, but also must husband her or his resources. *Economy:* To avoid endangering wastefulness, each individual must utilize resources with economy and not try impracticably both to acquire unattainable benefit and to avoid inevitable harm. *Efficiency:* To avoid problematically incomplete processing, each individual must efficiently deploy her or his limited information processing bandwidth, (*a*) by prioritizing allocation of bandwidth to most urgent events first, (*b*) by categorizing events early, to narrow the scope both of memory access and of subsequent processing, and (*c*) by consuming bandwidth for error checking only as confidence decreases and uncertainty increases. *Stability:* To avoid untenable positions, each individual must tailor her or his patterns of response to her or his adaptive niche, finding a stable position that is actuarially tenable across likely futures, and avoiding the instability of response that may lead to lethal untenability.



Global Goal Setting
Content-Rich
Signals (Cognition)
Content-Poor
Control Signals (Emotion)
Interrupt
& Prioritization
(Salience)
Categorization
& Response
Palette
Retrieval
Expectancies
for the Practicable
(Optimism and
Pessimism)
Filtering
for
Practicability
Response Selection
(ranked by
emotional
preference)
Settling
(Confidence vs.
Uncertainty and
Anxiety)
Local Goal Accomplishment
Contingency (Event Occurrence) and Urgency
(positive feedback event)
Detection
Percepts
Orientation
& Attention
Semantic
Analysis
Current
State-of-Affairs
Stimuli
Variables
(relations)
Under Control
Standardization
(disparity/error
analysis)
± Effectiveness
(positive feedback loop)
Current
State-of-Affairs
± Error from:
Timetable
Standard
Selected
Goal/Standard
(feedforward)
Corresponding
Timetable
Standards for
Harm and Benefit
(i.e., for valence)
(biology of
valence)
Responses
Behavior
Pragmatic
Analysis
Adjustments
Action
(dampening)
Sensitivity of
Error Detection

restricting the pallette of options retrieved for ranking.

Response evaluation: The valence of the positive feedback, positive and negative, signals current harm and benefit, which is global negative feedback with respect to the global reference to avoid harm, worst harm first, and to attain benefit. Current harm and benefit are considered in light of the bias of expected harm and benefit, in order to rank and select among response options.

Next goals: The selected response and the nominal timetable on which it should occur both feedforward reference information to the local process, giving the local process goals/standards/timetables to accomplish next.

Settling: The selected response's goodness-of-fit to circumstances, the individual's confidence in her or his ability to execute the response, and the cost of errors are all factored into the generation of a dampening signal. The dampening signal controls the local process' sensitivity to error. Sensitivity to error modulates the rate of settling on responses by controlling the amount of error-checking done, and thus also the hysteresis that controls the likelihood of further positive feedback events.

2.3.3 Expectancy Bias

The proposed adaptive control architecture is biased by expectancies for the practicable—maximum attainable benefit and minimum unavoidable harm. This pair of expectancies imposes an actuarially sound economy on patterns of response, by filtering out impracticable responses during real-time response selection: Resources are not wasted, vainly attempting to pursue what is expected to be unattainable or to avoid what is expected to be inevitable. Response is thus biased toward what is expected to be practicable and economical.

Because of their response characteristics—stability in the face of transients, some sensitivity to enduring change and zeroes that effect a reset—infinite impulse response filters (IIRs) (Hamming, 1989) model expectancies for the practicable, inputting experienced harm and benefit events. The economy consequently imposed, albeit *very* idiosyncratically tailored to the individual's adaptive niche, is typically tenable in stable niches, and stable enough to ignore transient changes. Yet IIR-expectancies are flexible enough to be responsive to some changing trends in circumstances.

3 Emotionally Governed, Expectancy Biased Adaptive Control

Biological and behavioral data suggest that *emotions are control signals* that govern response to changing circumstances, within expectancy biased adaptive control (Frankel, 1999). For an architecture of the complexity of expectancy biased adaptive control, the available empirical data on emotion are not sufficient to make a definitive case for this or any architecture. However, in addition to exhibiting strong intention and to being a kind of adequate solution to the problem of adaptive competence that natural selection would credibly favor, the proposed architecture is consistent with an abundance of data on emotion (only partially cited here). The proposed architecture thus makes a plausible, *constructive* case for emotion as a control signal in the production of competent, intentional behavior.

3.1 Defining Emotion

In psychology there is no agreement on how to define 'emotion', nor is there a single superordinate term that covers all of the phenomena that are in some sense emotional (Gross, 1998). Adding complexity, most psychologists use a naive taxonomy of psychological phenomena in which 'cognition' and 'information processing' are interchangeable, implicitly relegating emotion to a role where it can neither contain information nor be a descriptive or inferential process.

Herein, 'emotion' is used as the superordinate term, applicable to all realized and expected valence states that typically appraise harm and benefit. Realized valence that appraises realized harm and benefit is realized emotion. Expected valence that appraises expected harm and benefit is expected emotion. This is not to say that emotion encodes only valence; to the contrary, emotions typically encode many forms of appraisal, as described below. Rather, valenced appraisal of harm and benefit is the defining characteristic of (necessary and sufficient for) emotion. Emotions include valence states of any duration, from micro-momentary to lifespan. Emotions also include valence states of any abstraction, from hunger and pain, through fear, anger and happiness, to embarrassment, malaise and *ennui*.

3.2 Emotions As Control Signals

There are not yet definitive neurological data to show that emotions control orderly processing of change, since that would require a (non-existent) complete map of the brain showing the necessity of emotion throughout neural control of change processing. However, the available neurological data strongly support the necessity of emotion to be a reasonable hypothesis.

In two regions of the brain that are very separate, both physically and functionally, dramatic degradation of motivation and organization is observed when the brain's capacity for orderly emotional processing is damaged. (*a*) Lesions that include the amygdala and some surrounding tissue can flatten emotional response and disable the regulation of attention, disrupting the process of salience (LeDoux, 1992). (*b*) Lesions to the prefrontal lobes that disable the operation of emotions also disable the organization of motivation and behavior (Damasio, 1994). People with prefrontal lesions behave exactly like programmed control systems with control signal failure: They have procedural knowledge intact, but without operational emotions, cannot provide real-time control to behavior to execute knowledge.

The fact of two independent points of failure militates against coincidental co-location of emotion and control. While not in itself definitive evidence for the necessity of emotion for control, it is strong evidence for the reasonableness of a hypothesis of necessity.

3.3 Emotional Governance

In real-time, emotions appraise change and govern response, acting as control signals that (*a*) interrupt current activity and prioritize processing, (*b*) categorize events, (*c*) filter response options for expected practicability, (*d*) rank options for a favorable future and (*e*) modulate settling on the ranking response.

3.3.1 Emotional Onset: Urgency of Contingencies and Consequent Prioritized Interrupts

In order to interrupt current activities and to allocate processing bandwidth, emotions signal the relative urgency and priority of events in both emotional intensity and rate of emotional onset (on Figure 1, the positive feedback loop, the Contingencies control flow and the Salience process). Going off-timetable (including off-goal) is a contingency that triggers emotions (Carver & Scheier, 1990). Emotions raise alertness, altering the breadth of attention as needed (Derryberry & Tucker, 1994). Emotions orient attention to focus on change (Posner & Petersen, 1990). Finally, emotions begin to assess the change as potentially harmful or beneficial, and arouse the individual both autonomically and behaviorally (Lang, Bradley & Cuthbert, 1990). As a result, objects of attention take on sustained salience as a contingency interrupting activities in a prioritized way.

Dynamic Prioritization: Events of unequal priority yield a single emotion that reflects and focuses on the event of highest priority (Frijda, 1988). All lower priority events are queued, to be serviced after higher priority events, or else decaying from the queue as emotions decay. Events of equal priority can result in multiple, simultaneous "mixed" and possibly conflicting emotions.

3.3.2 Emotional Categorization: Memory Partitioning

After initial emotional onset, interrupt and shift of attention, emotions categorize events, signaling what kind of an event each event is, thereby partitioning memory, so as to access and process an appropriate palette of response options (on Figure 1, the Categorization process). While not yet converging on specific, neurologically embodied categories, many investigators agree that emotions categorize events (Ekman, 1992; Gray, 1990; Panksepp, 1989). Emotion categories are understood to reflect action tendencies (Frijda, Kuipers & ter Schure, 1989) rather than ballistic trajectories, because emotions decouple the contents of attention from otherwise reflexive response (Scherer, 1994). Emotional categories thus do not lead to rigidly stereotyped behaviors. Rather, once attention is focused, emotional categories prime memory so that a palette of responses is quickly retrieved, based upon responses' coherence with prevailing emotional appraisals of current circumstances.

3.3.3 Emotional Expectancy Biasing: Insuring Practicability

After categorization, the resultant palette of response options is biased to eliminate wastefully impracticable options that try either to attain what is expected to be unattainable positive emotion or to avoid what is expected to be inevitable negative emotion—and by proxy, unattainable benefit and inevitable harm (on Figure 1, the Expectancy and Practicability processes). The biasing filters are expectancies for maximum attainable positive emotion and minimum unavoidable negative emotion—proxies for maximum attainable benefit and minimum unavoidable harm (see section 4.2).

3.3.4 Emotional Valuation: Selecting Efficacious Responses

During response selection, emotional valence and intensity, expected and realized, control the ranking of the biased palette of options. (on Figure 1, Response Selection process, and Goal and Timetable feedforward control flows). The standard for ranking is emotionally risk-averse: *To avoid what are expected to be negative emotions, worst emotions first, and then to pursue what are expected to be positive emotions*. The ranking option and its timetable are selected and fed-forward.

Utility: Neurologically, the evaluation of stimuli (Davidson, 1992) and utility (Ito & Cacioppo, 1999) is encoded in emotional valence, biased toward aversion to the risk of negative emotions (Ito, Larsen, Smith & Cacioppo, 1998). Behaviorally, in ranking the utility of harm and benefit, contrary to prospect theory (Kahneman & Tversky, 1990), people avoid the negative emotion of regret associated with a loss, not the loss *per se* (Larrick, 1993). Regret avoidant options may be either risk avoidant or risk taking (Zeelenberg & van Dijk, 1997).

Negative emotion aversion: Regret is not the only strong aversion. Before people accept helplessness, they exhibit reactance (Brehm & Sensenig, 1966). Avoidance of anxiety is a powerful motivator (Greenberg, Pyszczynski, & Solomon, 1995). Shame avoidance increases aggression and narrows peoples' focus so that they do not take the perspectives of others, harming relationships (Tangney, Wagner, Hill-Barlow, Marschall & Gramzow, 1996). Abandonment and betrayal are also worst emotions that people typically avoid systematically.

Automaticity: The avoidance of worst emotions is often so automatic and so successful as often to occur completely outside of consciousness. For example, when people get dressed to go out at the start of their day, most do not give any conscious attention, thought or feeling to the fact that they are doing so, in part, to avoid the shame of going naked in a clothed world. Yet most people are immediately alarmed and avoidant at the suggestion.

3.3.5 Emotional Dampening: Confidence & Settling

Automaticity is the special case of settling, where the individual is fully confident that a selected response is beyond the possibility of error. More generally, once a response option has been selected and fed forward, the rate of response settling is modulated by the individual's emotional confidence *vs.* anxiety (on Figure 1, the Settling process and Sensitivity Dampening control flow).

Confidence: The individual's level of confidence reflects her or his belief (a) that the selected response is a certain fit to circumstances, (b) that the task difficulty is within capabilities and (c) that the cost of likely errors is affordable. The greater the individual's confidence, the more certain and compelling is the response, and thus the more dampened the individual's sensitivity to error and the more efficient the settling. After people select how to respond, their natural predilection is to be confident that they can implement their decision successfully (Taylor & Gollwitzer, 1995).

Uncertainty and anxiety: As the selected response is a poor or uncertain fit, as the response taxes abilities, or as the cost of errors increases, confidence lowers and anxiety increases. The greater the individual's anxiety and uncertainty, the less dampened is the sensitivity to error and either the slower and less efficient the settling, or else the more erratic the settling as time pressure increases. Anxiety reflects uncertainty (Epstein & Roupenian, 1970; Feather, 1963, 1965; Wright, 1984). Tolerable levels of both uncertainty (Siegman & Pope, 1965) and anxiety (Gray, 1990) slow settling. As stress increases, people make and consider fewer distinctions, rushing to settle before they have considered all available alternatives (Keinan, Friedland & Arad, 1991).

Settling strategies: Life is often very uncertain, and errors often costly, militating against easy settling. Yet competent settling demands a dampening function that modulates settling to match circumstances' rate of change. Failure to settle in time is often catastrophic, making it credible that natural selection would favor a design that creates punishing internal pressure to settle.

Faced with a punishing emotional dampening mechanism, people compromise on a preferred settling style. Sorrentino (*e.g.,* Sorrentino, Holmes, Hanna & Sharp, 1995) has found that some people ignore anxiety-raising discrepancies, settling rapidly, even prematurely, with certainty and confidence, and cleaving their social universe into trustworthy or not. Others have evenly modulated anxiety, error-checking and settling, taking in more information and subjecting it to more careful scrutiny, but seldom establishing a more than moderately trusting position.

Still others stay chronically anxious and inefficient, settling erratically. The chronically anxious prefer a narrow focus (Stoeber, 1996) on possible error at the expense of sometimes-important information. Anxious focus is biased toward the processing of threat, much of which is minor in nature, to which anxious people are more attentive, by which they are more distracted (McNally, 1996) and about which they ruminate. Worriers have low tolerance for uncertainty, are disproportionately sensitive to uncertainty, and expect uncertainty to bring failure (Shimkunas, 1970).

3.3.6 Coping and Emotion Repair

As demands increase, people increase their problem solving output to keep pace. Eventually, however, people reach a point where they are consistently too wrong or too late or both. People reach a breaking point, a positive feedback event where they recognize that they cannot keep pace, or where they decide that the costs exceed the benefits. At that breaking (inflection) point, the adaptive strategy shifts from problem solving to coping. People disengage from the focal problem, and either start addressing peripheral problems that staunch their loss of ground, or start directly repairing their negative emotion, or both. Moreover, if being pushed past the breaking point is accompanied by a concomitant shift of expectancies, people may not notice after demands decrease, and may resist re-engagement with problems.

3.3.7 Metastable Equilibrium - Failure to Settle

Adaptive control designs are vulnerable to metastable equilibrium. For people, goal conflict can produce this kind of failure to settle. The immediate result of conflicting demands and mixed emotions is increased stress, slowed response and high error rate (Smith & Gehl, 1974). Mixed emotional states are stressful and disruptive, and when sustained, result in high levels of negative emotion and psychosomatic complaints. Such ambivalent states demand substantial bandwidth to process, and stymie action (Emmons & King, 1988). Conflicting standards result in increased distractibility, uncertainty, and indecisiveness, thereby disorganizing motivation (van Hook & Higgins, 1988). People can panic in the face of irreducible goal conflict, producing a rush to settle; however, anxiety may also inhibit panic, creating paralysis (Gray & McNaughton, 1996). Unresolvable or irreconcilable demands are both seriously disorganizing and highly dysphoric.

3.4 Bias by Emotional Expectancies

To be actuarially tenable, patterns of response should be tailored to be (*a*) adequate to the largest range of likely futures in a given adaptive niche, (*b*) insensitive to transient changes in the niche, and (*c*) sensitive to changing trends in the niche. Responses are biased toward tenability by IIR filters (Optimism and Pessimism in Figure 1) that sample emotional valence events. IIRs formulate expectancies that ignore most transients and tracks some trends. As a result, the individual's emotional expectancies for the bounds of the emotionally practicable comprise a stable, idiosyncratic biasing to the individual's adaptive niche, reflecting her or his unique emotional experience, education and acculturation.

Valence expectancy is usually a cognitive construct, *e.g.,* self-esteem, possible self, ideal *vs.* ought self, prevention *vs.* promotion focus, or dispositional optimism *vs.* pessimism. However, all of these valenced constructs are predicated upon a common pair of underlying emotional expectancies. Maximum attainable benefit is the expectancy for the threshold beyond which benefit and positive emotion are not practicably attainable. Minimum unavoidable harm is the expectancy for the threshold below which harm and negative emotion are inevitable, *vs.* worse, avoidable harm and emotion.

People maintain expectancies for both positive and negative emotion (Marshall, Wortman, Kusulas, Hervig. & Vickers, 1992), each with a distinct neurological basis

(Davidson, 1993) Emotional expectancy comprises an assessed emotional trend, predicted from emotional events whenever they occur in an interval, with discrepant samples being ignored if they do not reflect the kind of trend that signals possible enduring change (Varey & Kahneman, 1992). Consistent with the smoothing of IIR output, emotional output is stably positive and negative over long intervals of time (Watson & Clark, 1984).

3.4.1 Stable Patterns of Emotional Response

Emotional expectancies stabilize patterns of appraisal. Emotional expectancies smooth emotions toward expected values (Wilson, Lisle, Kraft, & Wetzel, 1989), direct attention toward expectancy-consistent stimuli (Byrne & Eysenck, 1995), accept expectancy-consistent emotions as informative and reject expectancy-inconsistent emotions as noise (Gaspar & Clore, 1998), and disambiguate ambiguities and assess performance outcomes toward expectations (Brown & Dutton, 1997).

Emotional expectancies also stabilize patterns of emotional and behavioral response. People with high negative affectivity tend to experience stable discomfort, independent of time, situation or identifiable stressors (Watson & Walker, 1996). Pessimists tend to expect to feel worse, to experience lower life satisfaction and more depressive symptoms (Chang, Maydeu-Olivares & D'Zurilla, 1997) and to be more vulnerable to making negative self-assessments (Brown & Mankowski, 1993). The converse is true for optimistic people.

Emotional expectancies are often self-reinforcing. Optimists tend to stay socially engaged and focused on hopeful aspects of circumstances, while pessimists are likely to focus on stressful aspects of circumstances and to disengage from problems (Scheier, Weintraub & Carver, 1986). Keeping resources focused on problems for longer, an optimistic strategy is stochastically more likely to produce solutions and expectancy-reinforcing positive emotion. The pessimist withdraws resources sooner, increasing the risk of failure and expectancy-reinforcing negative emotion.

Emotional expectancies can be so stable and self-reinforcing that idiosyncratic patterns of response, tailored to one adaptive niche, often persist when the niche changes or when the individual is transplanted to another niche. Miscontextualized adaptations and coping strategies often persevere as overly stable, even rigidly psychopathological, individual differences. Although individual competence is not best served by such rigidity, the species' genetic fitness can benefit. The broad pallette of individuals' strategies available at any point in time increases the likelihood that some individuals will be well suited to new circumstances, when circumstances change.

3.4.2 Flexibility in Response to Changing Trends

Emotional expectancies for the practicable can change consistent with an IIR construction. IIRs can respond selectively to enduring change. IIRs also have regions of reset (zeroes), where surprise can make emotional expectancies change abruptly.

When dramatic life change results in enduringly different emotions, patterns of emotional expectancy can change. For example, falling in love heightens positive emotional expectancy—which typically then decays as romance cools and expectancies are not refreshed with enduring, strong positive emotions. Traumatic events and their sequellae often generate enduring emotional change that heightens negative emotional expectancies.

Surprise accompanied by sustained interest resets expectancies (that is, surprise is a zero of the IIR, driving IIR output to zero, no expectancy). Thereafter, expectancies assume values from post-surprise emotional events. At onset, the surprising stimulus is persistently salient (Meyer, Niepel, Rudolph, & Schuetzwohl, 1991). Processing slows, as people allocate processing resources for an attributional search (Stiensmeier-Pelster, Martini & Reisenzein, 1995). If attribution fails, one of three outcomes occurs. (a) The uninterpretable event is deemed unimportant and is ignored. (b) The uninterpretable event is deemed to have potentially catastrophic significance, provokes significant anxiety, and a defense is quickly settled upon. (c) An event that is deemed important but not catastrophically threatening, provokes at most tolerable anxiety and also sustained interest. This third type of surprise event, a "disturb-then-reframe" protocol, causes expectancies to take on new values (Davis & Knowles, 1999). Surprise and interest may also promote change in psychotherapy (Omer, 1990). The growing trust in a therapeutic alliance can be understood both to increase sensitivity to emotion by lowering the noise of anxiety, and to increase the tolerability of emotion, thus stochastically increasing the likelihood of transformative surprise events in treatment.

4 Ontological Binding of Intention to Motivation and Emotion

The proposed adaptive control architecture exhibits strong intention, but not necessarily intrinsic intention. Emotional control signaling, by contrast, is a fundamental intrinsic of human information processing. To complete the argument that emotions automate and effect the content of intentions, emotions and intentions must be linked. The bridging concept between intention and emotion is motivation. The causal force by means of which emotions govern behavior and effect intrinsic intention is *motive force.*

While not agreeing on the determinants of motivation, psychologists generally agree on the necessity of motivation: Without motivation, competently organized behavior is unlikely to occur on a sustained basis. While much motivation has extrinsic determinants, this paper takes the position that all motivation has a necessary intrinsic component that appraises the significance of extrinsic factors, in order to control the organization of behavior consistent with the content of intrinsic signification. For example, confronted with an extrinsic like a snake during a stroll, most people will be motivated to step around it, whereas a phobic might be motivated to leave the area, while a herpetologist might be motivated to pick up the snake and study it. To be realized, all motivation is implemented by an intrinsic motive force that effects the contents of intrinsic signification.

This decomposition of motivation suggests that the intrinsic component of motivation and intrinsic intention c e

With its flexible context (option) generation, its insight into the distant future, and as keeper of the broader social and moral contract, conscious volition can sometimes overcome an immediate and short-sighted impulse by injecting internal percepts of long term consequences, both of the impulse and of alternative

Chang, E. C., Maydeu-Olivares, A. & D'Zurilla, T. J. (1997) Optimism and pessimism as partially independent constructs: Relationship to positive and negative affectivity and psychological well-being. *Personality & Individual Differences, 23:* 433-440.

Damasio, A. R. (1994) *Descartes' error: Emotion, reason, and the human brain.* New York: G.P. Putnam.

Davidson, R. J. (1992). Prolegomenon to the structure of emotion: Gleanings from neuropsychology. *Cognition and Emotion, 6:* 245-268.

Davidson, R. J. (1993) Parsing affective space: Perspectives from neuropsychology and psychophysiology. *Neuropsychology, 7:* 464-475.

Davis, B. P. & Knowles, E. S. (1999) A disrupt-then-reframe technique of social influence. *Journal of Personality and Social Psychology, 72:* 192-199.

Dennett, D. C. (1996) *Kinds of minds.* New York: Basic Books.

Derryberry, D. & Tucker, D. (1994) Motivating the focus of attention. In P. M. Niedenthal & S. Kitayama (Eds.), *The heart's eye: Emotional influences in perception and attention,* (pp. 167-196). San Diego, CA: Academic Press.

Ekman, P. (1991) *Telling lies: Clues to deceit in the marketplace, politics and marriage.* New York: W.W. Norton.

Ekman, P. (1992) An argument for basic emotions. *Cognition and Emotion, 6:* 169-200.

Emmons, R. A. & King, L. A. (1988) Conflict among personal strivings: Immediate and long-term implications for psychological and physical well-being. *Journal of Personality and Social Psychology, 54:* 1040-1048.

Epstein, S. & Roupenian, A. (1970) Heart rate and skin conductance during experimentally induced anxiety: The effect of uncertainty about receiving a noxious stimulus. *Journal of Personality and Social Psychology, 16:* 20-28.

Feather, N. T. (1965) The relationship of expectation of success to need achievement and test anxiety. *Journal of Personality and Social Psychology, 1:* 118-126.

Feather, N. T. (1963) The effect of differential failure on expectation of success, reported anxiety, and response uncertainty. *Journal of Personality, 31:* 289-312.

Frankel, C. B. (1999) Such order from confusion sprung: Affect regulation and adaptive competence. Dissertation presented to the faculty of Pacific Graduate School of Psychology, Palo Alto, CA, USA

Frijda, N. (1988) The laws of emotion. *American Psychologist, 43:* 349-358.

Frijda, N., Kuipers, P. & ter Schure, E. (1989) Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57:* 212-228.

Gasper, K. & Clore, G. L. (1998) The persistent use of negative affect by anxious individuals to estimate risk. *Journal of Personality and Social Psychology, 74:* 1350-1363.

Gray, J. A. (1990) Brain systems that mediate both emotion and cognition. *Cognition and Emotion, 4:* 269-288.

Gray, J. A. & McNaughton, N. (1996) The neuropsychology of anxiety: Reprise. In D. Hope (Ed.), *Perspective on anxiety, panic and fear,* (pp. 61-134). Omaha, NB: University of Nebraska Press.

Greenberg, J., Pyszczynski, T. & Solomon, S. (1995) Toward a dual-motive depth psychology of self and social behavior. In M. H. Kernis (Ed.), *Efficacy, agency, and self-esteem,* (pp. 73-99). New York: Plenum Press.

Gross, J. J. (1998) The emerging field of emotion regulation: An integrative review. *Review of general psychology, 2:* 271-299.

Hamming, R. W. (1989) *Digital filters.* Englewood Cliffs, NJ: Prentice Hall.

Isermann, R., Lachmann, K.-H. & Matko, D. (1992) *Adaptive control systems.* New York: Prentice Hall.

Ito, T. A. & Cacioppo, J. T. (1999) The psychophysiology of utility appraisals. In D. Kahneman, E. Diener & N. Schwarz, (Eds.), *Well-being: The foundations of hedonic psychology*, (pp. 470-488). New York: Russell Sage Foundation.

Ito, T. A., Larsen, J. T., Smith, N. K. & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology, 75:* 887-900.

Kahneman, D. & Tversky, A. (1990) Prospect theory: An analysis of decision under risk. In P. K. Moser (Ed.), *Rationality in action: Contemporary approaches*, (pp. 140-170). New York: Cambridge University Press.

Keinan, G., Friedland, N. & Arad, L. (1991) Chunking and integration: Effects of stress on the structuring of information. *Cognition and Emotion, 5:* 133-145.

Lang, P. J., Bradley, M. M. & Cuthbert, B. N. (1990) Emotion, attention, and the startle reflex. *Psychological Review, 97:* 377-395.

Larrick, R. P. (1993) Motivational factors in decision theories: The role of self-protection.*Psychological Bulletin, 113:* 440-450.

LeDoux, J. E. (1993) Emotion & the amygdala. In J. P. Aggleton (Ed.), *The amygdala: Neurobiological aspects of emotion, memory, & mental dysfunction,* (pp. 339-351). New York: Wiley-Liss.

Marshall, G. N., Wortman, C. B., Kusulas, J. W., Hervig, L. K. & Vickers, R. R., Jr. (1992) Distinguishing optimism from pessimism: Relations to fundamental dimensions of mood and personality. *Journal of Personality and Social Psychology, 62:* 1067-1074.

McNally, R. J. (1996) Cognitive bias in anxiety disorders. In D. Hope (Ed.), *Perspectives on anxiety, panic and fear,* (pp. 213-250). Omaha, NB: University of Nebraska Press.

Meyer, W. U., Niepel, M., Rudolph, U. & Schuetzwohl, A. (1991) An experimental analysis of surprise. *Cognition and Emotion, 5:* 295-311.

Omer, H. (1990) Enhancing the impact of therapeutic interventions. *American Journal of Psychotherapy, 44:* 218-231.

Panksepp, J. (1989) The neurobiology of emotions: Of animal brains and human feelings. In H. Wagner & A. Manstead (Eds.), *Handbook of social psychophysiology,* (pp. 5-26). Chichester, UK: Wiley.

Posner, M. I. & Petersen, S. E. (1990) The attention system of the human brain. *Annual Review of Neuroscience, 13:* 25-42.

Scheier, M. F., Weintraub, J. K. & Carver, C. S. (1986) Coping with stress: Divergent strategies of optimists and pessimists. *Journal of Personality and Social Psychology, 51:* 1257-1264.

Scherer, K. R. (1994) Emotion serves to decouple stimulus and response. In P. Ekman and R. J. Davidson (Eds.), *The nature of emotions: Fundamental questions,* (pp.127-130). New York: Oxford University Press.

Searle, J. R. (1992) *The rediscovery of mind.* Cambridge, MA: MIT Press.

Searle, J.R. (1997) *The Construction of social reality.* New York: Free Press.

Siegman, A. W. & Pope, B. (1965) Effects of question specificity and anxiety-producing messages on verbal fluency in the initial interview. *Journal of Personality and Social Psychology, 2:* 522-530.

Shimkunas, A. M. (1970) Anxiety and expectancy change: The effects of failure and uncertainty. *Journal of Personality and Social Psychology, 15:* 34-42.

Smith, B. D. & Gehl, L. (1974) Multiple-exposure effects of resolutions of four basic conflict types. *Journal of Experimental Psychology, 102:* 50-55.

Sorrentino, R. M., Holmes, J. G., Hanna, S. E. & Sharp, A. (1995) Uncertainty orientation and trust in close relationships: Individual differences in cognitive styles. *Journal of Personality and Social Psychology, 68:* 314-327.

Stiensmeier-Pelster, J., Martini, A & Reisenzein, R. (1995) The role of surprise in the attribution process. *Cognition and Emotion, 9:* 5-31.

Stoeber, J. (1996) Anxiety and the regulation of complex problem situations: Playing it safe? In W. Battmann & S. Dutke (Eds.), *Processes of the molar regulation of behavior,* (pp.105-118). Scottsdale, AZ: Pabst Science Publishers.

Tangney, J. P., Wagner, P. E., Hill-Barlow, D., Marschall, D. E. & Gramzow, R. (1996) Relation of shame and guilt to constructive vs. destructive responses to anger across the lifespan. *Journal of Personality and Social Psychology, 70:* 797-809.

Taylor, S. E. & Gollwitzer, P. M. (1995) Effects of mindset on positive illusions. *Journal of Personality and Social Psychology, 69:* 213-226.

van Hook, E. & Higgins, E. T. (1988) Self-related problems beyond the self-concept: Motivational consequences of discrepant self-guides. *Journal of Personality and Social Psychology, 55:* 625-633.

Varey, C. A. & Kahneman, D. (1992) Experiences extended across time: Evaluation of moments and episodes. *Journal of Behavioral Decision Making, 5:* 169-185.

Watson, D. & Clark, L. A. (1984) Negative affectivity: The disposition to experience aversive emotional states. *Psychological Bulletin, 96:* 465-490.

Watson, D. & Walker, L. M. (1996) The long-term stability and predictive validity of trait measures of affect. *Journal of Personality and Social Psychology, 70:* 567-577.

Wilson, T. D., Lisle, D. J., Kraft, D. & Wetzel, C. G. (1989) Preferences as expectation-driven inferences: Effects of affective expectations on affective experience. *Journal of Personality and Social Psychology, 56:* 519-530.

Wright, R. A. (1984) Motivation, anxiety, and the difficulty of avoidant control. *Journal of Personality and Social Psychology, 46:* 1376-1388.

Zeelenberg, M. & van Dijk, E. (1997) A reverse sunk cost effect in risky decision making: Sometimes we have too much invested to gamble. *Journal of Economic Psychology, 18,* 677-691.