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REVIEW ARTICLE

Toward an Operational Model of Decision Making, Emotional Regulation, and Mental Health Impact

Thomas F. Collura, PhD, QEEG-D, BCN, LPC; Carlos P. Zalaquett, PhD, LMHC; Ronald J. Bonnstetter, PhD; Seria J Chatters, PhD

ABSTRACT

Current brain research increasingly reveals the underlying mechanisms and processes of human behavior, cognition, and emotion. In addition to being of interest to a wide range of scientists, educators, and professionals, as well as laypeople, brain-based models are of particular value in a clinical setting. Psychiatrists, psychologists, counselors, and other mental health professionals are in need of operational models that integrate recent findings in the physical, cognitive, and emotional domains, and offer a common language for interdisciplinary understanding and communication. Based on individual traits, predispositions, and responses to stimuli, we can begin to identify emotional and behavioral pathways and mental processing patterns. The purpose of this article is to present a brain-path activation model to understand individual differences in decision making and psychopathology. The first section discusses the role of frontal lobe electroencephalography (EEG) asymmetry, summarizes state- and trait-based models of decision making, and provides a more complex analysis that supplements the traditional simple left-right brain model. Key components of the new model are the introduction of right hemisphere parallel and left hemisphere serial scanning in rendering decisions, and the proposition of pathways that incorporate both past experiences as well as future implications into the decision process. Main attributes of each decision-making mechanism are provided. The second section applies the model within the realm of clinical mental health as a tool to understand specific human behavior and pathology. Applications include general and chronic anxiety, depression, paranoia, risk taking, and the pathways employed when well-functioning operational integration is observed. Finally, specific applications such as meditation and mindfulness are offered to facilitate positive functioning.(*Adv Mind Body Med.* 2014;28(4):18-33.)

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Progress in brain research provides a new understanding of the mechanisms and processes underlying human behavior, cognition, and emotion.[1,2] Neuroscientific research demonstrates both the basic biological substrates of cognitive functions, such as attention, reasoning, and decision making, and the impact of these mind-based functions on neurogenesis and neuronal systems. Neuroscientific research supports the effectiveness of counseling and therapy, reveals the underlying mechanisms of change, and promotes the integration of these fields. It also asserts that counseling and psychotherapy are both mind and brain therapy because they produce measurable and lasting physical changes in the brain.[2-4]

Neuroscience provides unique opportunities to observe and measure various aspects of human thought, feeling, and behavior[5]; personality styles[6]; and the influence of contextual factors on brain development, feelings, and behaviors.[7,8]

Neuroscientific technologies such as functional magnetic resonance (fMRI), positron emission tomography (PET), and electroencephalography (EEG) neurofeedback (NFB) make it possible to study the biological substrates of responses that are driven by trait (eg, personality and state; situation).[9-12]

The purpose of this article is to present a brain-path activation model to understand individual differences in decision making and psychopathology. The first section discusses the role of frontal-lobe EEG asymmetry and summarizes state- and trait-based models of decision making. The second section presents a model for understanding human behavior and pathology.

MODELS OF DECISION MAKING

Brain Asymmetry

Studies of brain asymmetries in frontal-cortex activity demonstrate that the presence of relatively greater left-frontal activity signals approach-oriented responses, such as accepting, linking, preferring, and choosing. These responses are accompanied by emotions such as anger or joy. In contrast, the presence of relatively greater right-frontal activity signals withdrawal-oriented responses, such as rejecting, disliking, and avoiding. These responses are accompanied by emotions such as disgust, fear, or sadness.[13-15]

Current conceptualizations of asymmetrical responses in frontal-lobe EEG activity assert that individuals have a tendency to respond predominantly with either approach or withdrawal actions or decisions across all or most situations. This trait-based conceptual model suggests that individuals' responses across situations reveal their personality styles or dispositions. Further, these responses can be associated with factors that have an impact on individuals' goals or survival.[16,17] On the other hand, state-based or dispositional conceptualizations recognize the existence of individual differences in frontal EEG asymmetry but suggest that these reactions interact with the demands of specific situations. This state-based conceptual model suggests that individuals' responses vary across situations as a function of the emotional demands of those situations and the individual's capacity to self-regulate at that moment.[14] Whereas traits are associated with individual qualities that are expressed in relatively consistent mood or activation levels, states are identified as transient reactions to specific stimuli and are considered as being of a particular duration in time.

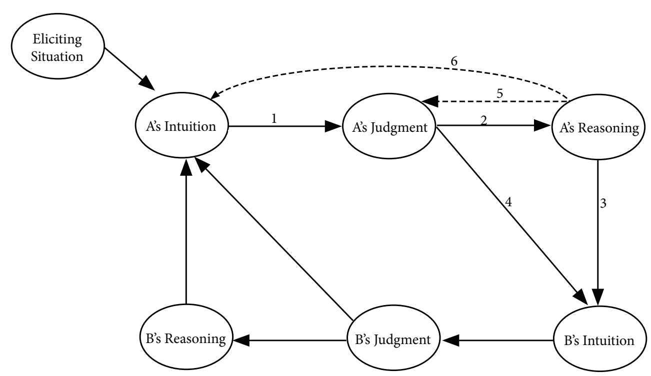
Trait- and state-based models offer different ways to conceptualize individual differences in frontal EEG asymmetry. Both emphasize the role of emotion and the valence, or quality, that clients assign to their experiences as the factors causing frontal-lobe asymmetry.[14,16] From a neuroscientific and mental health perspective, emotions can outweigh reason or knowledge in determining how and when decisions will be made and how individuals interact with their internal as well as external worlds. Thus, emotions are a key element in human behavior and mental health.

At a certain level, all decisions may be emotional. Individuals strive to make objective decisions based on rational input, but emotions accompany such processes and result in a sense of satisfaction and security from decisions made in the face of a complete and thorough assessment. Similarly, it is difficult to imagine a person feeling comfortable in securing a plan that is accompanied by a strong sense of trepidation or fear. Moreover, any path that an individual pursues is accompanied by a sense of personal judgment as to whether it is safe to proceed or whether all possible considerations have been fully evaluated.

Other conceptualizations, such as Haidt's social intuitive model for moral judgment,[18] also acknowledge the driving role of what Haidt refers to as intuition in decision making. These models assert that a reasoned justification for an individual's judgment takes place after the decision is made. Haidt's model also includes pathways for social interactions that can alter perceptions and influence final judgments.

Although the fields of neuroscience and mental health acknowledge the role of emotions in decision making, understanding is hampered by a need for more precise models of neurological pathways and a common vocabulary among fields. By drawing from the work presented above, the authors are able to generate new insights and merge the unique contributions of varied fields. An additional benefit of this merging could be the development of a common terminology to facilitate communication. Haidt's model, as presented in the book *The Emotional Dog and Its Rational Tail: A Social Intuitionist Approach to Moral Judgment,*[18] advances decision models by including brain pathways and offering insights into specific decision-making brain activity. With regard to the current topic, this model provides a means to identify information flow between 2 individuals, incorporating 2 forms of information (Figure 1). These forms are (1) intuition, which may be associated with emotional decisions; and (2) judgment, which may be associated with anticipation of consequences and knowledge of rules. This model thus provides a framework

Figure 1. Haidt's Social Intuitive Model[a]

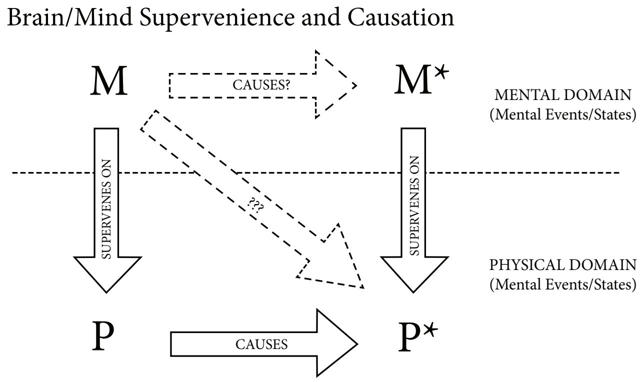


[a]Representation of information flow between 2 individuals, A and B, incorporating 2 forms of information obtained through intuition and judgment. Intuition (primary emotion/sensation) and judgment (secondary emotion/perception) are key components to the proposed operational model.

for not only individual A's response to an eliciting situation but also for the interaction with another person B. In this model, persons A and B could be a client and a therapist, 2 members of a couple, or any 2 individuals with a particular, definable relationship. This model is thus foundational to the authors' analysis of emotional and rational decision making, because it applies to human interactions of various types. It is also worth noting that the Haidt model exists entirely on the physical plane when the interaction is examined as part of an information-exchange system. Its media include verbal, written, facial, and other forms of physical communication, and every node is thus accessible to observation.

Additional studies have established the role and implications of brain asymmetries in executive functions, approach-and-avoidance motivation, and anger[19,20] as well as in mental disorders such as anxiety and depression.[21,22] In the individual model described here, as well as in Haidt's social intuitionist framework, the clear identification of the processes of emotional response and emotional decision making provides a functional underpinning that is useful in assessment as well as in treatment planning and therapeutic intervention.

Figure 2. The Supervenience Model[a]



Abbreviations: M = mental; P = physical.

[a]Schematic model of the relationship between brain and mind, and the role of supervenience.

In Search of an Integrative Model

Counselors and other mental health professionals are in need of operational models that integrate current neuroscientific concepts and offer a common language for interdisciplinary understanding and communication. Integrative models could guide assessment, treatment, and evaluation of clients' outcomes.

Integrative models have the capacity to bridge mind and body and give rise to a holistic view of humans. According to Kandel,[2] psychotherapy is a biological treatment, or a brain therapy. According to Ivey and Zalaquett[3,4] counseling is neuroscience. Both the counseling view and the medical view assert that the talk cure changes the brain and mind. Counselors and psychotherapists have the tools to alter brain physiology and function by virtue of interventions that change clients. These professionals are able to influence the reward patterns and reasoning processes as well as the emotional responses that define clients' needs and capabilities.

Current progress in neuroscience and mental health provides the basis to understand and advance integrative models. The supervenience model presented in Figure 2 provides exemplifies such interdisciplinary integration. The model describes the challenges to applying neuroscientific principles to mental health issues. Practitioners and theorists are faced with 2 apparent domains—the physical and the mental—that can be regarded as self-contained, with separate vocabularies, rules, and principles. Thus, a purely mentally based, talk-therapy approach may make no use of neuroscientific principles. Similarly, a purely scientific approach to clients' concerns could restrict itself to neurotransmitters, hormones, and other physically accessible interventions. Indeed, both extremes of therapists exist in practice, providing purely mentally based or purely physically based (generally pharmaceutically based) treatments. An apparent problem exists in that each domain is considered to have its own set of entities, causes, and effects, yet both may be applied to the same individual at the same time. When 1 effect is purported to have 2 causes, an apparent paradox arises that is logically difficult, if not impossible, to understand.

At any instant, we identify mental states or events, and also associate with them physical states or events that occur in the brain, that underlie the mental. We indicate that a given mental event, M, is followed by another mental event, M*. We also have the associated physical event, P, which consists of the brain events that are associated with (produce?) the mental state M. The physical state, P*, is similarly associated with the mental event M*. The top level is the mental, and we commonly say that one mental event can cause another mental event. This is shown with a question mark (?) because this causation is being put into question. The bottom level, being the physical, has its own laws, and we commonly say that one physical event causes another (eg, the action of a neurotransmitter causes membrane changes). We are also of the impression that mental events can cause physical events (ie, my desire to move my arm causes the movement of the arm). Because it is not possible for a given result to have 2 causes, this diagram points out a problem in our thinking. The relationship between brain and mind proposed by Kim[23,24] is that of supervenience. This states that, simply, the only relationship we can affirm is that, if 2 physical states are the same, that the associated mental states will be the same. The mental realm thus reflects or indicates what is happening on the physical but does not cause physical events, and mental events themselves have no role as causes. Our model is thus focused on the physical realm and how the associated mental (and emotional) events express themselves.

The supervenience model was developed by Jaegwon Kim[23,24] of Brown University. He articulated the relationships between domains that are thought to be derived from one another in terms of the concept of supervenience. This concept is helpful when considering emergent properties, such as the mind that we regard as emerging from the processes of the brain yet being an entity with its own qualities and properties. Generally, the authors have worked under the thinking that the physical domain somehow determines or creates the mental domain, wherein mental processes are mediated by brain events and emerge in their own right as mental experiences. It is worth noting again that all of the interpersonal processes in Haidt's model by definition occur on the physical plane, being mediated by sights, sounds, and other physical processes. Thus, a comprehensive model of decision making must integrate both the physical and the mental domains.

The supervenience model suggests solutions that can facilitate the integration of mind and body in a clinically useful way. Rather than appealing to the idea of causes and effects, it simply states that 2 domains can be related by stating the conditions under which the scientist can identify differences between any 2 states. Figure 2 illustrates the domains and the paths of causation from one state to another. This simple illustration precisely identifies the issues that researchers face when applying neuroscientific principles to clinical mental health. To state briefly the idea of supervenience in this situation, the mind supervenes on the brain if no change or difference in the mental domain is possible without a corresponding change in the physical domain. This concept allows the authors to focus their analysis on physical processes, with the view that mental events emerge from the physical yet have their own unique qualities and properties.

As a working definition, the authors take the view that the physical processes in the brain and body are entirely sufficient to determine the mental events, although the converse is not necessarily true. Researchers can come to regard the mental or subjective domain as a passenger or observer rather than as a primary causative agent. A mental event is produced by, but is not identical to, physical processes. As examples of other emergent properties, consider indices on a stock exchange or public opinions. These properties exist solely by virtue of processes that are firmly based on individual interests and behaviors yet emerge with a life of their own and exist on their own unique levels of organization.

When applying this point of view, the authors place their primary attention on events and processes that are identifiable on the physical domain while recognizing the existence of the mental as dependent on or supervenient to these events and processes. The authors are thus able to avoid constructs such as "he felt *xyz*, and 'it' made him do it," while they move toward "his decision-making process was associated with such and such brain events, and it was also accompanied by these particular affective experiences or states." Indeed, they identify mental states, such as subjective intention, as being produced by brain events, not the other way around. Studies by Libet[25,26] have shown that subjective perceptions of intention are preceded and thus caused by, rather than being the cause of, brain events associated with voluntary movements.

Integrative models of counseling and neuroscience have the capacity to resolve the paradoxes inherent in traditional, dichotomous, mind-body thinking. Mental-health practitioners tend to think of the brain and mind as 2 entities that occupy somewhat different domains. They have the sense that causes and effects exist on the physical level and, in parallel, their clients also have causes and effects on the mental level. An example of a physical cause and effect might be that of ingesting a toxin that can cause tissue damage. Individuals secondarily attribute any pain or discomfort that they might experience to this damage. It is on the physical level that some mental health practitioners apply pharmaceutical solutions to mental concerns, relying on the brain's responses to resolve the presenting problems. On the mental level, other mental health practitioners might state that a decision to reconsider a problem might lead to a change in the emotions related to the problem. This latter domain is where cognitive-behavioral and related therapies work, if the scientist disregards the reality that the talk itself is a physical phenomenon mediated by the airwaves. Despite the fact that we know that it is a physical process that conveys verbal, gestural, and other information between therapist and client, the salient processes are thought of as somehow "existing" or "happening" in the domain of the mental realm. Given that the talk has produced a desired mental response, scientists then infer that the sequence of mental causality leads to the desired change.

The Integrative Model

The authors' model begins with the basic functional delineation put forth by Davidson[27] in which a difference exists in the hemispheric roles of the left and right sides of the brain. According to this model, the right hemisphere is responsible for negative emotional states, whereas the left hemisphere is responsible for positive emotions. Further, the frontal hemispheres undertake somewhat different tasks.

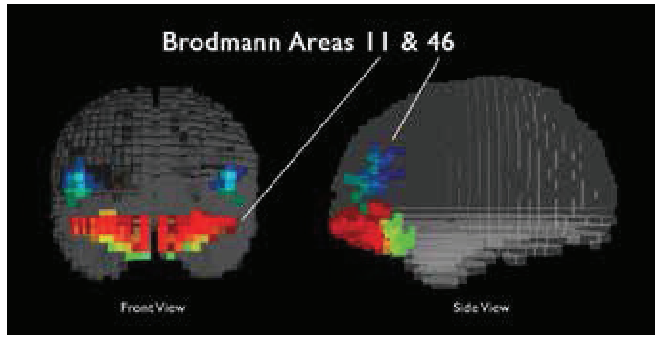
The left hemisphere performs serial processing, scanning various aspects of the environment in support of decision making. This process is akin to how language is processed sequentially. The left hemisphere is responsible for assigning the value "good," "safe," or "approach" to the current situation. An important aspect of this processing is that the serial scanner must decide if it has considered enough information to render the decision as positive. If that result does not occur, then the individual does not feel comfortable with his or her decision. This lack of comfort happens to be a situation that occurs in many cases of chronic depression.[27-29] Upon investigation using techniques such as the fMRI, it has been found that "patients with depression show an impaired ability to modulate emotional states and to process positive emotional information."[28] This impairment is in contrast to their ability to process negative emotional information, which has been found to be normal, showing that depressed people do not overemphasize the negative. Rather, they de-emphasize or even ignore the positive.

The right hemisphere performs a parallel scan in which many considerations are reviewed at once. This method is the most efficient means for determining whether a situation is safe. When danger exists, such as a lion in the room, it is not necessary to attend to details to make a fast decision to defend oneself or to retreat. It is most efficient for the brain to assign a parallel scanning mechanism that can detect danger or indicate the need for withdrawal (flight) or defensive behavior (fight). When danger is detected, the right hemisphere must quickly render a decision and inform the individual that a negative emotion or reaction is appropriate. Whether a reaction actually occurs depends on further intact processing and decision making that leads to a behavioral or cognitive consequence.

Davidson's model[27] also distinguishes between primary emotional responses to stimuli and secondary emotional and decision-making responses. The frontal, emotional processing system has a similar organization to the visual system that initially performs a first sensational phase in the primary visual cortex, followed by second perceptual phase in the association cortex. During the initial phase of response processing in the frontal lobe, information from the sensory systems first enters the midbrain and then passes through the nucleus accumbens and the medial-forebrain bundle, from which it is sent to the medial frontal cortex. This process produces an emotional sensation that does not reflect much, if any, integrative processing. The signals from the frontal cortex are then sent back to posterior regions of the frontal cortex, comprising the premotor areas. There they are integrated with further information and then sent back to the frontal cortex, but this time the signals move to the dorsolateral regions. It is in these regions that the emotional information is integrated with contextual information to give the emotion meaning and relevance to the individual's experience and goals. Therefore, in a model using brain activation data as an indicator of emotional processing and decision making, it is possible to identify initial emotional responses with the medial frontal cortex, while attaching more complex emotional processing, decision making, and emotional comprehension to activity that occurs in the dorsolateral regions. These areas are presented in Figure 3 as Brodmann Areas 11 and 46. Brodmann was a 19th-century scientist who classified (and numbered) regions of the brain based on observations made with a microscope and sensitive stains. His classification and numbering system remains in use today. Each particular area that Brodmann identified and numbered is referred to as a "Brodmann Area."

In the figure shown, the 2 areas in red are Brodmann Areas 11. These are in the mesial prefrontal cortex and perform functions including primary emotional sensations. The 2 regions in blue are Brodmann Areas 46. These are responsible for secondary processing, or emotional perception. In these and other illustrations, green and blue indicate states of relative inactivity, whereas orange and red

Figure 3. Brodmann Areas 11 and 46



indicate areas or relative activity. These measurements are based on surface EEG measurements and are processed using the sLORETA algorithm to estimate brain activity at the cellular level.

The authors' model expands previous literature, equating left-hemisphere activation with positive emotion and right-hemisphere activation with negative emotion. The relationship between the individual and the environment as well as salient decision-making criteria are important. The authors recognize the critical value of negative emotions and the important role of the avoidance response in inhibiting potentially dangerous behavior. Therefore, right-hemisphere function is not necessarily a negative role because it includes an element of introductory caution, protecting the individual by inhibiting actions that may have adverse consequences. Exerting such a function makes evolutionary sense because it increases the chances of survival.

Based on observations of individuals who were undertaking a difficult and challenging task, it became clear to the authors that right-hemisphere activity, depending on the circumstances, did not necessarily equate to a negative emotion. Rather, it simply indicated that a parallel scanning was underway, pending a determination that the situation was safe. In other words, when a genuine possibility of danger exists, prominent right-hemisphere activation reflects caution and appropriate response, not simply a negative reaction. Based on the authors' model, negative mood states can be elicited in any situation where the parallel scanning mechanism is activated in the absence of credible evidence that any possible danger exists. A chronic activation of this mechanism—whether by maladaptive mechanisms, posttraumatic stress, or other coping or compensating patterns—leaves the brain with negative emotions and reduces its adaptive value. This chronic state is a form of rigidity, in that it limits the possible range of responses that are possible. Individuals who are prone to this process aberration will tend to experience depression, anxiety, discomfort, and other negative moods in a chronic manner, in contrast to experiencing negative mood states solely in response to particular stimuli or triggers.

Another important feature of the model is the fact that the right hemisphere can pass concerns to the left hemisphere for consideration. This feature can lead to an endless cycle in which the individual is continually asking "what if?" and can produce a seemingly endless list of worries for the left hemisphere to ponder, thus never allowing it to render a positive decision to move on. Clearly, in potentially dangerous, particularly unfamiliar circumstances, testing pattern after pattern in further detail to assess its possible future impact has survival value. By feeding the serial scanner (left brain) with one scenario after another, the likelihood of an overall judgment of "safe" or "approach" is reduced, pending completion of all of the "what if" testing. Although this process is important in genuinely threatening or unfamiliar settings, the individual can deprive himself or herself of ever feeling safe or positive if this process becomes chronic, in which case the process produces a quagmire of negative thoughts and concerns.

In summary, researchers have observed that many people with chronic depression actually have a normal reaction to negative circumstances and do not necessarily exaggerate them. Rather, these individuals do not have the ability to process positive events. Therefore, chronic depression is more a matter of the inability to process positive information rather than the production of excessive negative judgments by the brain directly.[27-29] However, even if the depressed brain is not directly experiencing excess negative emotions, it is still inhibiting positive mood states, by virtue of the interaction of the hemispheres. For example, an individual whose left hemisphere is stuck in an infinite loop and who constantly audits the situation but never renders a positive decision will remain stuck with only the negative judgments from the right hemisphere to consider due to the lack of positive data.

The examples that the authors present in the following text show particular patterns of frontal-lobe activation using EEG gamma (35-50 Hz), demonstrating different responses. These responses were produced using a BrainMaster BrainAvatar system with a 19-channel Discovery EEG amplifier (BrainAvatar, Bedford, Ohio, USA). Images were produced by applying the sLORETA algorithm to the EEG, producing a 3-dimensional image of brain activity in the form of current-source-density images. Because this system has a very fast response time (30 milliseconds), it is possible to create precise, instantaneous, event-related images of brain activity in contrast to the very slow (5-8 seconds) response of other techniques, such as the fMRI. The drawings that follow are referenced as if an individual is looking out of the page at the reader. Therefore, the right hemisphere of the brain is shown on the left side of the drawing, and the left hemisphere of the brain occupies the right side of the drawing.

This front view shows the frontal lobes of the brain. Areas of green and blue are relatively inactive, whereas areas of orange and red are relatively active. The subject is "looking out" of the page. In the baseline measurement, the relatively high activation (red) on the right cortex indicates a generally depressed or negative mood. In the reaction to chocolate chip cookies (lower left), the negative state is seen to be somewhat relieved, but is still slightly negative. When beer is presented, the state becomes even more negative. This generally depressed client reacts positively to cookies but does not like beer.

The image at the top of Figure 4 depicts a dominating right-hemisphere baseline status of a clinically depressed client during a wellness assessment. Words and phrases were flashed on the screen, and sLORETA gamma images were generated. Although showing a reduced intensity of cortical activity, the client's reaction to her favorite food, chocolate chip cookies, still generates a right-hemisphere response, as indicated by the yellow and red areas in the graphic at the bottom left. As a comparison, the extensive red area in the graphic at the bottom right shows a major aversion to the word *beer*. The schematic view of this hemispheric interaction

Figure 4. Baseline and Reaction Frontal Asymmetries in a Depressed Client

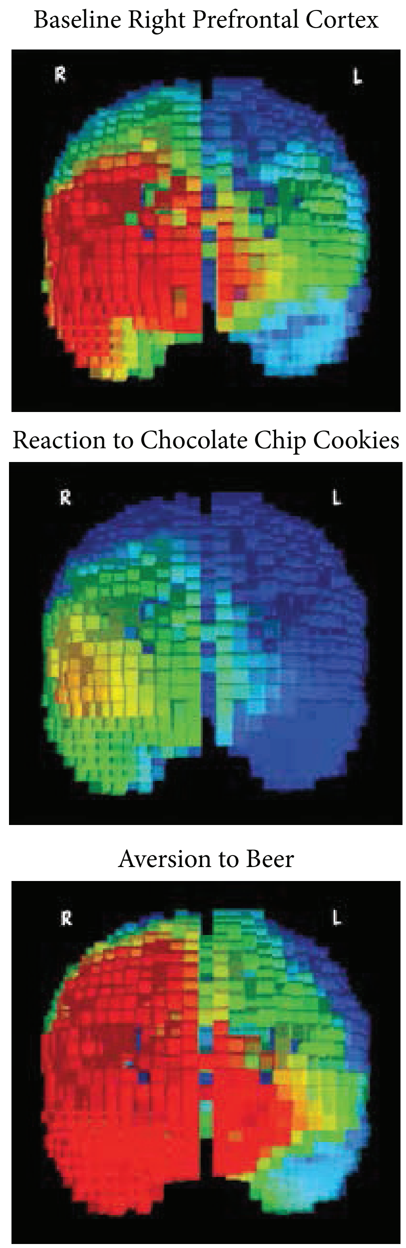
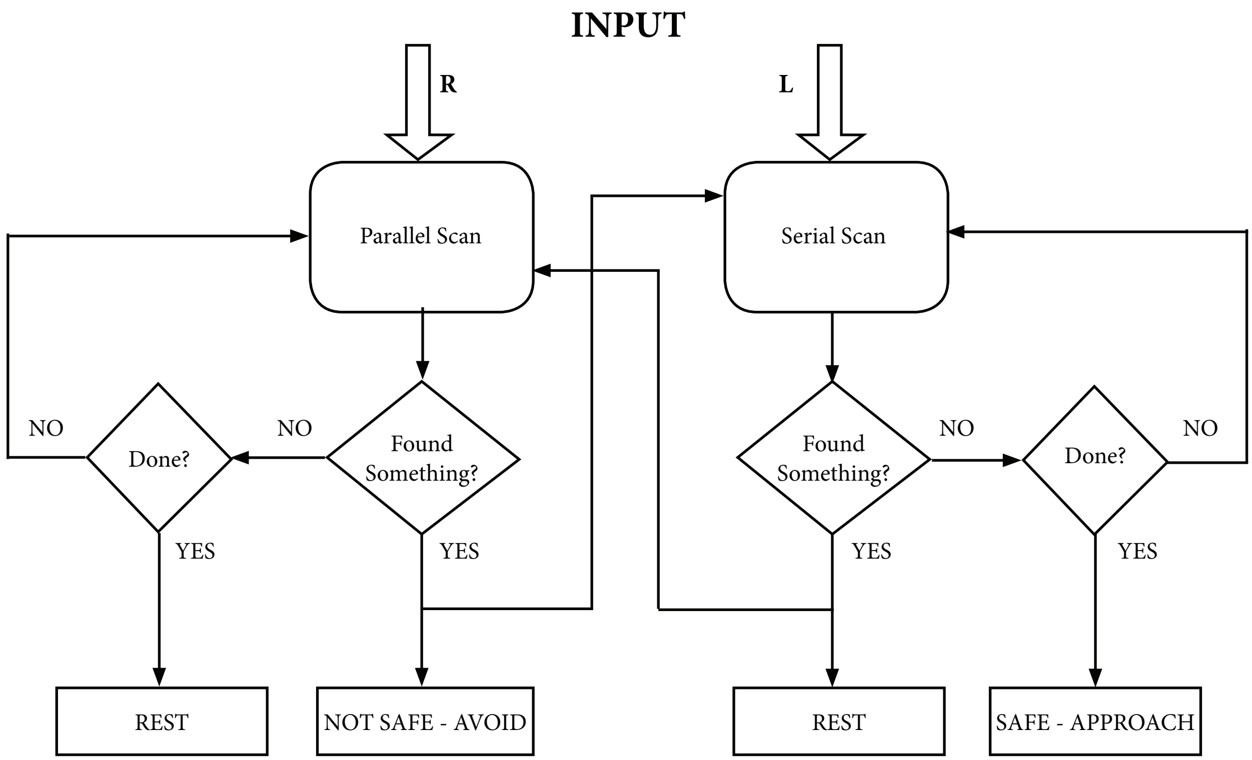


Figure 5. Possible Pathways for Decision Making and Potential Consequences[a]



[a]The proposed operational model places the functions identified with the frontal lobes of the brain into a schematic, decision-making form that shows the differences between the right and left sides of the brain. The right frontal lobe performs a parallel (everything at once) scan and looks primarily for danger or reasons to avoid. The left frontal lobe performs a serial (1 thing at a time) scan and is responsible for ensuring that all possibilities have been considered, and that a situation or decision is safe, or should be approached. A key difference is that altough the danger mechanism can render a decision in a split second, the safety mechanism must perform many sequences of analysis, before being sure that all possible dangers or concerns have been considered.

in Figure 5 represents possible pathways for decision making and their potential consequences.

An important distinction can be made between the serial (left brain) and the parallel (right brain) scanning mechanisms with regard to timeframe. Whereas the serial scan is future-oriented and is responsible for evaluating "what if" scenarios, the parallel scan is primarily past-oriented and relies on pattern recognition. For example, when evaluating possible danger, the parallel scan looks at previous scenarios and attempts to do a rapid pattern match with past dangers. This process underlies the mechanism of learning what is dangerous and responding quickly.

One possible aberration occurs when excessive matching, or inappropriate generalization, happens in which many, if not all, scenarios are being judged as potentially dangerous. Inappropriate generalization can occur in circumstances that lead an individual to fear a wider range of inputs to ensure safety or survival. This practice basically means minimizing risk by maximizing avoidance. An example would be someone who avoids all seafood because some items may be unhealthy or tainted. Rather than expend the time and energy to investigate further, an entire range of possibilities is summarily excluded from consideration. An overuse of the protective reasoning of "the last time I saw this…" can result in a generally negative, possibly paranoid state.

Another extreme can occur if the parallel scan is disconnected from the serial scan, resulting in an impairment in anticipating negative consequences. Risk taking and other deviant behavior can result. This disconnection, which can show up neurophysiologically as hypocoherence in the EEG, is associated with attentional and self-regulation problems in general as well as with behavioral and emotional disorders such as ADD/ADHD and autism.[30]

The serial scanning mechanism operates on the principle of comparing possible futures with what is desirable. Therefore, it anticipates possible outcomes based also on past learning of causal relationships and looks to ensure that all possible outcomes are safe.

A key distinction between the 2 mechanisms is the use of spatial versus temporal methods of comparison. The parallel scan (right brain) is essentially a template match that uses arbitrary composite representations of past experience and looks for similarity with current experiential input.[31] Although this comparison can be thought of as an image overlay or comparative type of judgment, the information need not only be visual. Auditory, kinesthetic, olfactory, tactile, or any other type of experiential modality may be encoded in what is being scanned for a template match. For example, motion can stimulate memories associated with fear or enjoyment and fit into the overall judgment as can images, smells, sounds, or other experiences. The result of a parallel scan may be essentially instantaneous because of the underlying mechanism, which is a form of distributed processing making use of interference patterns, producing a result after a single pass through the network.[26,31]

The serial scanner (left brain), in contrast, uses a temporal model, one in which events are put in sequence according to rules of causality or custom and are used to create possible future scenarios. The serial scan makes use of the elements of sequence and order as well as identification of events that may or must precede certain other events. This fact is why this mode of scanning is in principle potentially more exhaustive, as well as more time-consuming, than parallel scanning. Further, although the parallel (danger)-scanning mechanism can find a single important finding and immediately return its judgment of "not safe," the serial scanner must be more exhaustive before rendering a safe judgment. The amount of scanning necessary to determine "enough" is in fact another variable in this system. When the list of dangerous items is short, scanning will be faster, and more "safe" judgments will occur. When the list is longer, scanning will take longer, and a reduction in the amount of judgments of a positive type will occur. In fact, if the list is considered to be arbitrarily large or "never enough," then the individual will effectively deny himself or herself the benefit of ever feeling safe, no matter how much evidence points to the fact that undesirable consequences are unlikely.

The serial scan is constructive and is creative because it analyzes possible consequences and uses details in its analysis. This mechanism uses past experience to discern rules, laws, consequences, and possibilities. To this end, it employs symbolic reasoning, including language, and has the ability to construct scenarios that can guide future actions. When securing a safe judgment from a serial scan, details must be considered. The serial scan is less about overall patterns and more about what specific detail could make the difference in any situation.

The parallel scan, in contrast, is destructive and reductive, because it tries to reduce patterns to what they resemble generally rather than fill in their details. It uses past experience only in terms of whether things appear similar. It does not deal with rules, laws, or language; rather, it seeks to lump every experience into manageable categories, simply to decide what to do right now. It looks for commonalities and neglects details that may differentiate patterns. The primary function of this scanning mechanism is to reduce the myriad details of complex experiences into basic categories that relate to the need to react. It matters little what the lion in the room looks like; a person wants to leave the room when any lion is present. This process is not limited to processing the instantaneous "now" but can incorporate past experiences as part of an overall information landscape that it perceives. For example, someone might have a bad feeling that they are getting into an undesirable situation, perhaps in business or travel, without identifying a specific danger. In cases where unusual senses or premonitions occur, it is possible that this mechanism is acting on a complex set of past data, including previous thoughts or feelings themselves.

For example, Gerald Edelman[32] has described from a neural Darwinist perspective how neuronal networks, such as the human visual system, have the ability to learn and thus become recognition automata that can enhance survival potential. Such networks self-organize based on their own input and produce instantaneous classifiers that can learn to distinguish and recognize objects by shape, motion, presence of edges, kinesthetic signals, or virtually any quality that can be encoded in the neural stream. Researchers can thus think of the parallel scanner (right brain) as a system that can start to discern and lock onto virtually any quality of experience. These qualities are not limited to the obvious ones of shape, color, size, and so on but can include complex situational, nonverbal, pheromonal, and other influences that are out of reach of individual awareness and conscious decision making. The parallel scanner reduces this cacophony of input into simple judgments that ultimately reduce to the 2 options of "there is a problem here" or "there is not a problem here."

Table 1 summarizes the key attributes of these 2 scanning systems. This description provides a more complex, derivative analysis that supplements the traditional, simple left brain-right brain model that has developed over the years.

In addition to the distinct differences in the function of the 2 frontal hemispheres, an important role exists that is related to their ability to intercommunicate. The communication between the 2 scanning mechanisms is what allows the parallel scanner, for example, to pass a concern to the logical reasoning process. An individual who is continually worrying and asking "what if?" about possible negative outcomes, finds the serial scanning (left brain) process burdened, and at times, overwhelmed with the need to evaluate scenarios. This situation leads to states of anxiety and fear and can inhibit personal growth and action. The converse connection, in which the serial scanning mechanism discovers something that is potentially a concern, is the path that allows the system to identify a potentially serious, future, adverse outcome and to initiate withdrawal behavior. Because this process is complex, requiring both hemispheres, individuals with a lack of connectivity between the left and right frontal areas will suffer from the inability to anticipate possible adverse outcomes and to modulate their behavior.[30]

As an answer to the question of why it appears to be so difficult to simply remain happy, the model provides an explanation. For the serial scanning mechanism to initiate a "safe" response, the system must pass through a sufficient amount of scanning to deem the process done. An analogy

Table 1. A Comparison of Parallel and Serial Scan Properties[a]

Mechanism	Parallel	Serial
Hemisphere	Right	Left
Data representation	Holographic	Sequential
Perspective	Visuo-spatial	Temporo-linguistic
Analogous to	Pictures	Music, speech
Context	Global (this situation always…)	Local (in this particular case,…)
Orientation	Patterns	Lists
Tasking	Multitasking (may be stressful)	Single-tasking (focused, calm)
Perspective	Past	Future
Dimension	Space	Time
Attribute	Patterns	Causality
Memory	Past patterns, "punishment"	Cause/effect experiences, rules
Mode of analysis	"the last time…"	"what if…"
Result	Avoid/Attack	Approach/remain
Emotion	Negative	Positive
Decision cycle	One analysis	Sequence of analyses
Activation sequence	One "found"	Many "not founds," then done
Priority	Detecting danger	Ensuring safety
Decision priority	Immediate	Long-term
Approach	Tactical, here and now	Strategic, future outcomes
Equation parameters[b]	Pp+ = 1, Ppf = 1	Ps+ = 1, Psf = 1
Associated behaviors	Run; fight	Breathe; build
Neurotransmitter	Adrenaline	Serotonin

[a]Comparison of the properties of the 2 scanning mechanisms in the frontal lobes of the brain.
[b]These parameters are described in the text and in Table 2.

with another circumstance is appropriate. For example, "How long does it take to audit a set of books and determine that everything is alright?" The answer is that it takes considerable time. An internal auditor, for example, may spend days, weeks, or months poring over records, looking for every conceivable problem. Only after continued and careful scrutiny can the auditor declare a set of records "good." On the other hand, "How long does it take to audit a set of books and determine that something is wrong?" The answer is that it may take almost no time at all. For as soon as any discrepancy or suspicious aspect is found, the auditor can stop right there and state that the audit has failed. The left hemisphere in the current analogy is like the internal auditor, who requires time to make a judgment, whereas the right hemisphere is like the tax inspector, who comes in one morning and has done all the damage before lunch. So the reason that individuals may struggle with remaining positive is that it takes time and work to do all the auditing and thinking necessary to become confident that everything is in fact fine. In some cases, this positive judgment may never be forthcoming, leaving the unfortunate individual in a perpetual state of depression or anxiety.

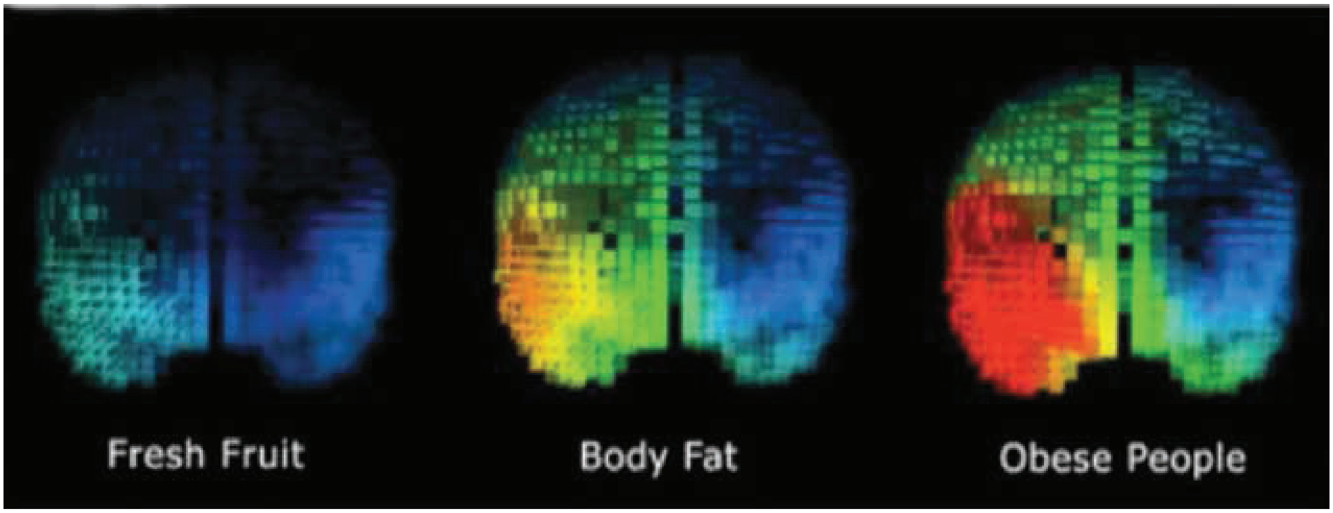
THE REALM OF CLINICAL MENTAL HEALTH

Implications of the Scanning Systems

Recognizing that negative emotions have their proper place in normal mental functioning is important, and the process cannot be regarded as a thing to be avoided.[33] As a simple thought experiment that demonstrates the importance of negative emotions, consider what would happen if an individual were to wake up one morning and, through miraculous intervention, be completely satisfied and content. What would his or her behavior be? If the person were truly completely content, he or she might not get out of bed at all. When the authors ask this question, they sometimes get the response, "I might like to get up and enjoy nature," or "I would want to go help others." Both of these responses include a sense of lack, something to be fulfilled. Whenever someone says "I might like" or "I want," that person is expressing a negative emotion, from a sense that something is not yet as it should be and that something must be done about it. Reasons for doing things include "I know I should," "I want," "I need," "I would like," "I always," "I have to," or other phrases. All such considerations are derived from a sense of negative emotion.

Another important undertone to this model is the realization that doing many things at once is intrinsically stressful. The right hemisphere operates by virtue of parallel processing, which is one way of doing many things at a time. This process is akin to the common practice of multitasking, in which an individual attempts to e-mail, carry on a conversation, make coffee, and think about work at the same time. Similarly, doing additional tasks while driving, such as eating or using a cell phone, has been found to elevate blood

Figure 6. Reactions to Words[a]



[a]Event-related brain images of an individual's reactions to the words shown. As described in the text, the client is generally negative and reacts negatively to the words *body fat* but extremely negatively to the words *obese people*. It was discovered during further questioning that this client had an abnormal reaction to this concept and in fact had an eating disorder.

pressure and to increase stress. The left hemisphere in its serial, sequential mode of scanning is intrinsically more focused and relaxed in its process. Therefore, it is reasonable to apply this line of thought to practical counseling and to encourage clients to be more focused, sequential, and methodical as a strategy for maintaining positive outlook. Research on meditation and mindfulness supports this point of view.[34,35]

Another implication of this model is that an individual might be happier and secure if he or she were convinced that a smaller number of scanning operations would suffice to ensure adequate safety. This idea is tantamount to shortening the list of items that must be considered so that the serial scanning can deem itself done. This process amounts to developing trust that the environment and its outcomes are predictable and generally safe. This proviso emerges in common culture (eg, in the adage, "A loaf of bread, a jug of wine, and thou by my side", which is a list of precisely 3 factors to be considered). Another example might be the lyric, "I've got the sun in the morning and the moon at night," which is a list of exactly 2 items that the author requires to be satisfied.

Paring down the list of things to be considered is one strategy to maximize safety while not being overwhelmed by concerns. Another strategy, improving the efficiency of the scanning system while maintaining a higher level of exploration and experience, would have additional advantages. Through learning, an individual learns to gauge a wide range of experiences quickly, and safety can be balanced with exploration and adventure, providing a more adaptable style. The opposite is somewhat reflected in the statement that "the price of liberty is eternal vigilance." This strategy depends on thinking more, not less. If the list of potential dangers is artificially reduced by ignoring essential items, risk taking, and other dangerous behavior could result.

This clarification can be used clinically by pinpointing concerns and attitudes that prevent clients from reaching sufficiently positive levels of mood or judgment on the one hand or from reaching excessive positive judgments on the other. For example, a clinician might focus on the question "What are the things that you trust will generally turn out OK?" If this list is short, then a substantial burden awaits the individual seeking decisions. Things left off of the trusted list must be continually re-evaluated. A client who elevates a litany of concerns regarding daily challenges or worries can be expected to be less prone to feeling good at any particular time. Addressing this level of trust can directly elevate the potential for happiness by clearing the way for the left hemisphere to pass positive findings along. This practice is consistent with the finding that cognitive-behavioral interventions can produce beneficial results when worries are explicitly addressed and resolved as part of the therapeutic process.

An example of a clinical application in the area of wellness can be seen in Figure 6. All 3 images depict a right-hemisphere gamma response to stimuli. In this example, even fresh fruit elicits a degree of concern. As before, blue and green tones represent relatively inactive brain regions, whereas orange and red indicate relatively high levels of activity. As described in the text, the client is generally negative and reacts negatively to the words *body fat* but extremely negatively to the words *obese people*. It was discovered during further questioning that this client had an abnormal reaction to this concept, and in fact she had an eating disorder. When the client was asked to offer an explanation for this reaction to fresh fruit, she stated that "any food in excess is bad for you." A similar concern was offered toward the concept of body fat and obese people, but when asked to offer an explanation for the intensity of the reaction to obesity, the client became agitated, and when pushed to explain how body fat and obesity might be so different, the client angrily stated, "Well, when I was a kid, I used to be anorexic!" The visualization of brain activity allowed the therapist to open a dialog to the possibility that this person was still harboring anorexic thoughts.

With regard to the opposite, overly positive judgments, an individual who is excessively prone to this approach will find that he or she is engaged in situations or pursuits that reflect a corresponding lack of caution or forethought. Asking such a client, "Were you able to ask yourself whether this decision was dangerous?" will enable the clinician to determine whether consequences were considered, at least in the client's own awareness. If the response is, "Yes, I knew it would be dangerous," then the clinician could inquire whether that awareness had any effect on the person's choices. The question would address a concern as to whether the processes necessary for the client to make a decision to alter behavior were intact, particularly in the face of knowing that a decision could be hazardous.

A contrasting view can be taken with regard to factors that elevate the likelihood that the right hemisphere will perform a negatively charged pattern match and set off a negative response. The question, "What are the things that automatically set you off?" can be directed to pinpoint specific areas. If the client responds, "I always think that people will say I did a poor job," then it would follow that any job-related input has a higher likelihood of setting off a negative response. Among other things, subjectively and behaviorally this individual would be described as tending to jump to conclusions about things that could go wrong, in contrast to allowing himself or herself to trust that certain things just might turn out all right without worrying about them. This situation is another one that can include the inappropriate generalizations described previously. It is a valuable safety mechanism to avoid the unfamiliar until further knowledge is acquired. Children, for example, may keep a very limited diet and not eat foods with an unfamiliar appearance, taste, or texture, until their adult palates develop. Although avoiding foods may not be a specific cause of emotional distress, a pattern of avoiding situations or experiences due to chronic negative reactions will limit possible futures and can become a source of distress and dysfunction.

Generally overthinking or processing through a large list of concerns tends to postpone positive feelings and put them on a more contingent basis. Similarly, when an individual is in a stressful or unfamiliar situation, additional serial scanning is initiated by the right hemisphere and requires the attention of the left hemisphere. This scanning will introduce a delay, or bottleneck, in what would otherwise be a reasonable degree of progress. In a recent discussion with a client who had been a professional driver, it was noted that drivers tend to slow down when the weather turns colder in anticipation of possible hazards, even if no snow, ice, or rain is occurring. Although no particular reason exists as to why driving in colder weather is more dangerous, the thought that a higher likelihood exists of possible precipitation, snow or ice, causes drivers to be more cautious, as they do a more detailed job of processing the environment and possible related decisions.

It also follows from this model that another path to happiness and confidence is experience. The more an individual is able to discern threatening from nonthreatening elements, the more he or she can make decisions without undue concern. For example, if a person is nervous about unfamiliar foods, then learning about them and understanding what actually tastes good can help when confronted with foreign dishes. Similarly, in social situations, someone who is withdrawn and has minimal social contact will lack the experiences with which to judge when to approach, when to behave in a certain way, and when others are likely either to appreciate or be offended by his or her speech or actions.

In summary, this model provides a framework in which to place specific decision-making predispositions and beliefs and to put them into a working functional model in which clients' affective responses and decisions can be seen as the result of a well-defined process. By monitoring momentary activation results, clinicians can determine if responses follow appropriate paths and patterns. The hemispheres could be inspected in conjunction with interventions to determine if clients have a proper response sequence reflecting a healthy and flexible system versus a rigid or dysfunctional one.

In terms of the brain's electrical activity associated with this model, the authors can generally state that the primary emotional responses embodied in the initial scanning mechanisms are present in the medial frontal areas, also known as the supraorbital cortex. This area resides above the eyes and occupies the inner concavities of the frontal lobes. These areas are the ones in which sensory information is first passed from lower brain centers forward to the frontal lobes. The secondary processing, involving comparing information with past memory and assigning value or valence to the experience, is associated with the dorsolateral frontal areas, which comprise the outer convexities of the frontal lobes. The communication between the lobes is embodied in the ability of the 2 mechanisms to share information. This sharing appears in the form of the coherence between frontal lobes, which is an EEG measure of connectivity that reflects the amount of information sharing on a moment-to-moment basis.

As another important, clinically relevant confirmation of this model, the authors observe that a common therapeutic intervention for depression is to down-train alpha and thus activate the left hemisphere. That procedure involves operant learning in which the client is rewarded with positive feedback (sounds or images) when the level of alpha is reduced below a threshold level. As a result, the client's alpha level may reduce generally, as the training generalizes. With reference to the authors' model, note that the 2 output options are either "safe" or "rest" in the left hemisphere. However, rest is a state of relaxation, which is associated with higher alpha waves. Thus, down-training alpha on the left is precisely one way to move that hemisphere out of its rest state, making it possible to achieve a “safe” judgment. It is of note that left-hemisphere activation has been found efficacious for depression, rather than deactivating the right.[36]

An interesting approach to probing this model in an individual would be to present inputs of different qualities, depending on whether they contain real or superficial danger and whether they would stand up to a thoughtful analysis. Ethical decision making can also be approached in this way. For example, a scenario such as “Someone has been struck on the head” clearly contains negative, initial, emotional content and also produces a negative result on further analysis. An ethical statement such as, “A client has given you an expensive watch,” on the other hand, may contain a positive initial response but, on thought, violates ethical principles and could get a counselor into trouble. Similarly, when someone encounters a potentially dangerous image such as a wildcat, a response based on fear might be appropriate. Further images showing the animal to be tame and harmless would produce a positive response in a longer timeframe. Clients who are presented with different scenarios, particularly clients with histories of deviant or criminal behavior, might produce interesting brain responses when viewed according to this overall model.

MEDITATION AND MINDFULNESS

It is during meditation that serial (left brain) and parallel (right brain) processing can operate in the absence of external input. Nonetheless, the individual experiences the resultant judgments based upon the simple recycling of information within and between these processes. If an individual is inclined toward negative conclusions and is not particularly active in appreciating positive aspects, then a negative mood might prevail. This mood could be accompanied by rumination, guilt, worry, or other negative affect. On the other hand, a positive mood can ensue if an individual is capable of withholding negative judgment and also allowing himself or herself to believe that the need to scan for possible hazards has passed. Further, by operating in the absence of overt input, particularly stressors, the system allows itself to find a balance in which both mechanisms can remain flexible and may be called into action but without undue or chronic emotional responses.

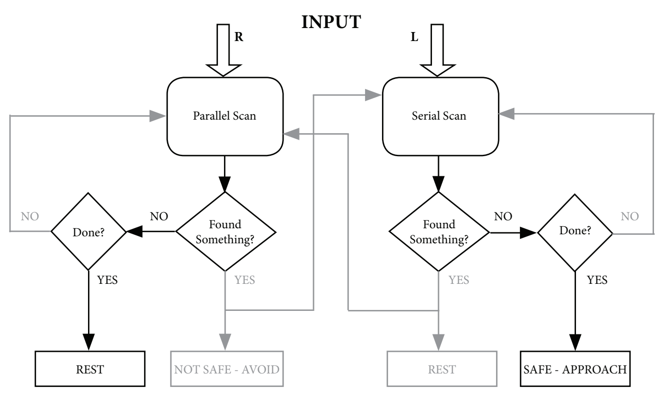
Mindfulness literally allows the contents of these processes to enter consciousness and to come under scrutiny themselves. An individual who is able to reflect, such as by thinking “The reason I feel this way is …” or “I understand that I react to situations such as … by feeling or doing …” has the tools to perform a meta-analysis of his or her own internal states. The issues of meditation and mindfulness bring up the question of how the networks function in a given individual in the absence of input. The dynamics of this process describe the resting or chronic emotional tone that is characteristic of the person. In the absence of input, the system could enter a particularly negative state by pondering past mistakes or it could remain flexible yet positive. The choice leads to the subjective and behavioral characteristics that are part of the presenting picture for each individual.

Examples of Patterns

The following examples of patterns may be used when inspecting individual brain images to determine the underlying processes for each individual in response to each item. Although on the surface this analysis may seem mechanical, even dehumanizing, it can offer an empowering element for both clinician and client. This approach has the potential to move dialog away from generalizations such as “You always look at the bad side,” or “You don’t know how to take risks,” or worse, “You are chronically depressed” into a more objective and understandable form. In the authors’ experience, it is possible to use these insights with clients with compassion and understanding, even humor, as clients become more self-aware. This sharing can elicit some light relief, even laughter. For example, after explaining a client’s tendencies with this model, a therapist might recapitulate with a comment such as, “If I showed you something wrong with your leg and told you why you limped, you wouldn’t be offended, would you? You wouldn’t be offended if I called you a weak-knee, bad-jointed limper guy, would you? (Laughter) So if I can point out something in your brain that is getting in your way, you won’t be offended either, right? So we won’t talk about disorders or labels; we will talk about what is happening in your brain and what we can do about it.” The client generally buys in.

Generally Happy Brain. The generally happy brain is able to exercise both sides, and although the parallel/danger mechanism is generally at rest, the serial/safe mechanism is able to render sufficient safe judgments to result in a positive mood.

Figure 7. Generally Happy Brain[a]



[a]In this brain, the mechanism that is looking for danger (parallel) has not found anything of concern and is further in a “done” state. The safety mechanism (serial) has also not found anything of concern and is also “done,” and it produces a “safe” judgment that is passed to the emotional centers to produce an overall “approach” reaction. When these mechanisms are both operating, the individual can feel safe, and confident that if there is a concern, it will be detected.

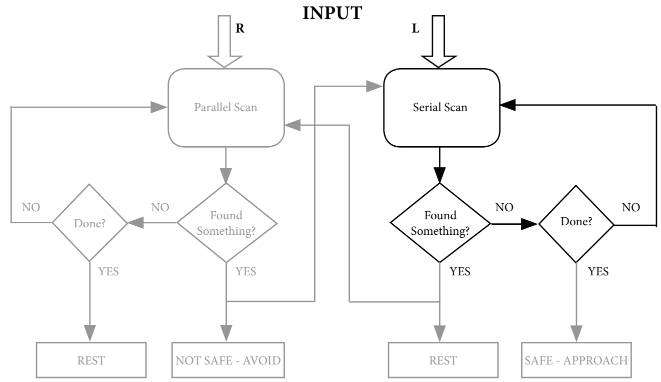
Generalized Anxiety. In this case, the generalized anxiety pattern never renders a safe judgment nor does it render a not-safe judgment. The result is a dysphoric or dysthymic state, with the client not really knowing why.

Chronic Anxiety. Chronic anxiety is the result of many overt, "not safe" judgments, in the absence of "safe" judgments. Continual avoidance is the result, accompanied by a negative mood.

Chronically Depressed. A chronically depressed state can result when the parallel scanner continually finds circumstances unapproachable, resulting in isolation and noninvolvement in activities.

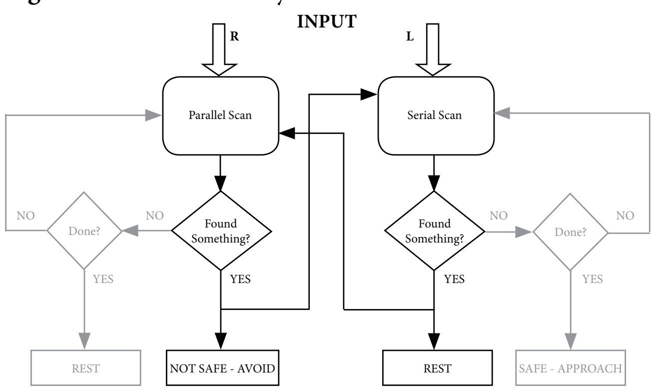
Paranoid. A paranoid state results when everything is simply judged unsafe, regardless of the specific input or circumstances.

Figure 8. Generalized Anxiety[a]



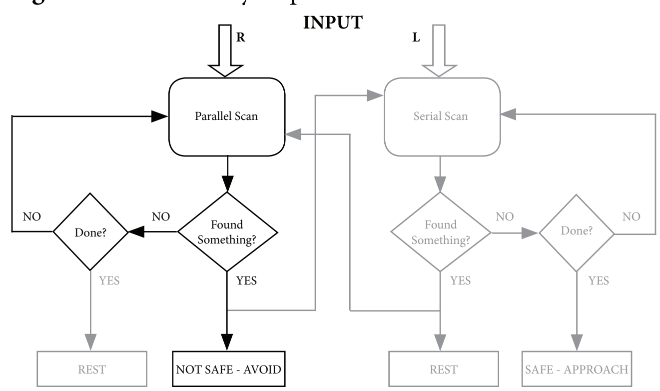
[a]In this brain, the serial scanning mechanism that looks for safety never considers itself done and is stuck in an endless loop. Therefore, this brain never feels safe. At the same time, it does not know the reason it does not feel safe, so this is a generalized condition, not due to a specific concern.

Figure 9. Chronic Anxiety[a]



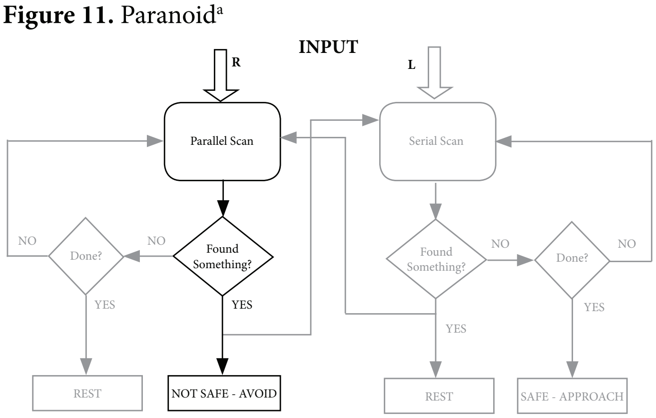
[a]Some individuals who are chronically anxious, even avoidant, actually feel unsafe, because the parallel scanning mechanism is rendering "not safe" judgments. At the same time, the serial scan that should be able to indicate safety at some point is simply at rest and is not producing positive emotional decisions.

Figure 10. Chronically Depressed[a]



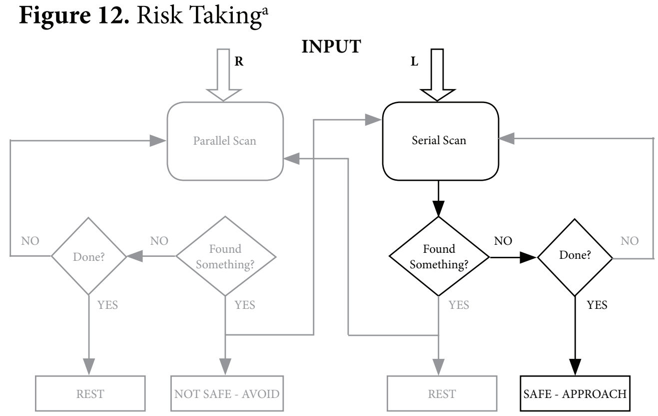
[a]If the parallel mechanism is working, and rendering unsafe judgments, and further never considers itself done, the individual will experience an unending and self-reinforcing sense of negativity.

Figure 11. Paranoid[a]



[a]A purely paranoid (avoidant) emotional decision condition is reached when every stimulus simply produces a negative response.

Figure 12. Risk Taking[a]



[a]If the serial scanning component renders "safe" judgments even in the face of possible dangers, the individual will not have avoidant capabilities. An individual may enter dangerous situations while thinking there is no danger, if this brain dysregulation pattern occurs.

Risk Taking. The risk-taking model indicates the use of a serial scan only, resulting in the following path: found something, "No," and therefore, "done"; however, ultimately the choices are not safe. The pathway does not allow for the individual to draw on lessons learned from past mistakes or on previous learning.

A QUANTITATIVE APPROACH

This discussion has focused on the introduction of a neurologically motivated model that presents an operational view of emotional decision making in terms of particular functions and pathways. When such functions or pathways are hampered or overactive, aberrations in decision making and emotional control can be identified. Rather than being an all-or-nothing phenomena, these decision-making processes are quantitative and are more appropriately characterized as probabilities that depend on the likelihood that the individual will respond in a particular way to particular inputs. These inputs may be sensory inputs, or they may be thoughts or emotions themselves, which are processed as input. Thus, the authors suggest that thinking and feeling are actually behaviors in a biological sense, because the individual subjectively experiences or lives in his or her thoughts and feelings, which are fundamentally brain-based events. For example, conscious awareness, including awareness of feeling, is associated with the insular area of the brain.[37] Researchers believe that all subjective experience may be mediated by this structure. These experiences of thought and feeling also constitute 1 component of the individual's environment, in that they re-enter the system as input.

The authors anticipate a further refinement of this model (Figure 13) in which each transition point and functional decision is represented as a quantity that reflects the probabilities of various decision processes (Table 2).

Table 2. Decision-making Tendencies[a]

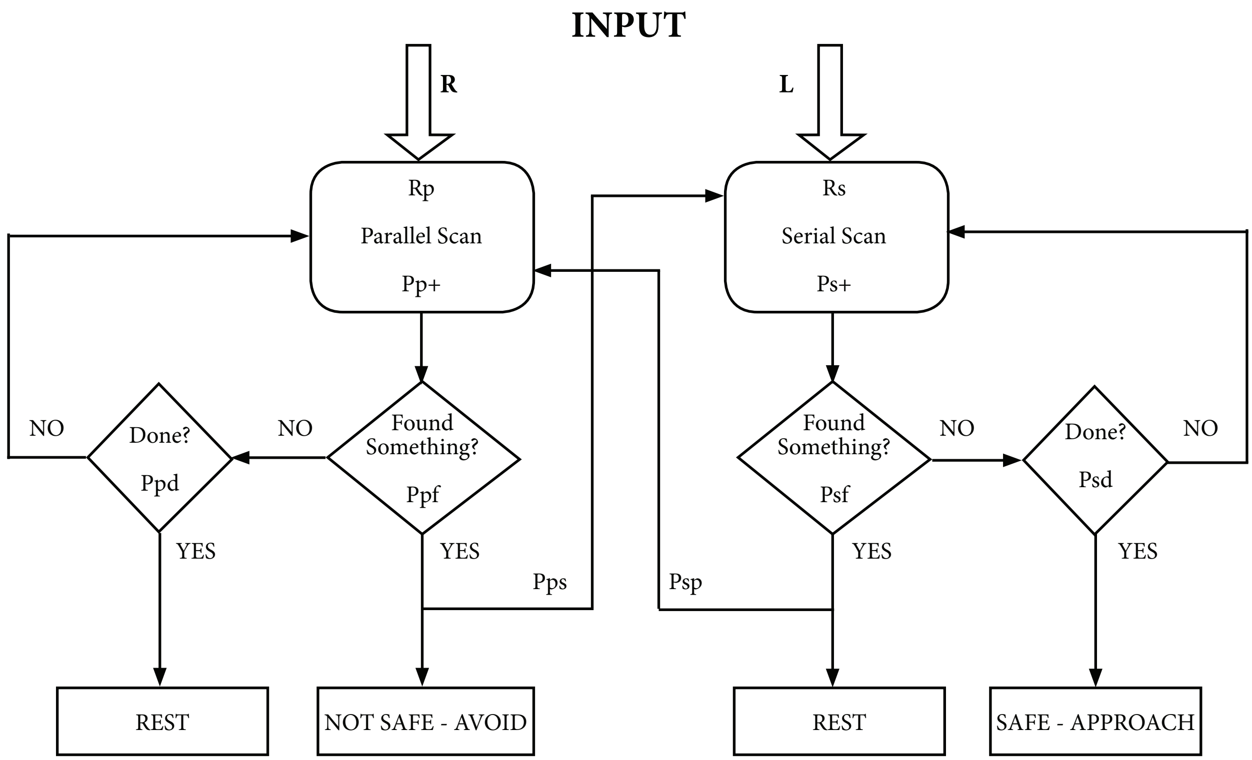
Emotion Vector   EV = (Rp, Pp+, Ppf, Ppd, Ppd, Rs, Ps+, Psf, Psd, Psp)

Rp	Rate of Parallel processing: patterns/second enters primary emotional sensation
Pp+	Probability that parallel processing will pass information on to seconday processing
Ppf	Probability that parallel processing will return "found" based on important level of input
Ppd	Probability that parallel processing will return "done" after processing a pattern
Pps	Probability that parallel processing will pass finding on to the serial processing of "found"
Rs	Rate of serial processing: scans/second enters primary emotional sensation
Ps+	Probability that serial processing will will pass inforamtion on to secondary processing.
Psf	Probability that serial processing with return "found" based on importance level of input
Psd	Probability that serial processing will return "done" after processing a pattern
Psp	Probability that serial processing will pass findings on to parallel processing if "found"

Examples	Rp	Pp+	Ppf	Ppd	Pps	Rs	Ps+	Psf	Psd	Psp
Happy	1	1	0	1	1	1	1	0	1	1
Paranoid	1	1	1	0	0	0	0	0	0	0
Anxious	1	1	1	0	1	1	1	1	0	1
Trauma	+	+	+	-						

[a]Summary of the probabilities defining an individual's emotional decision-making tendency. Each piece of an emotional decision is quantified by a probability that the decision will be made in a particular way. The examples show how setting specific probabilities to 1 or 0, a specific type of brain response pattern can be described. This provides a means of breaking down complex emotional decisions into specific operations that are either highly likely (probability near 1) or unlikely (probability near 0)

Figure 13. Operational Model With Probabilities Inserted in Each Decision Point[a]



Note: See Table 2 for an explanation of the abbreviations.

[a]This quantified version allows one to interpret brain dynamics and decision making in terms of the tendency to make a particular decision. The presence (or absence) of components in the previous examples can now be replaced by simply placing quantities on each probability, which show the likelihood that the individual will follow a given emotional or decision-making path.

It is possible to perform the equivalent of removing, or establishing with high certainty, any of the above configurations by assigning values to these rates or probabilities. These probabilities can be combined into what we can regard as an overall vector of the individual's mood-processing state, either in the resting state or in response to particular inputs. By defining the collection of all such probabilities, the authors can create a system that classifies and describes individual propensities for reaction as well as tendencies for endogenous states. Thus, conditions such as chronic anxiety or chronic depression can be identified with particular transitions that are either less active than would be optimal or more active. These transitions define the individual response patterns and provide an opportunity for individual therapeutic interventions. For example, if a client is found to be strongly inhibited in a transition that decides that "I have worried enough," then therapy can concentrate on that specific aspect and can be focused on a goal that is tangible and measurable.

Because this proposed vector comprises 10 entries, 1024 (2 to the 10th power) generally definable configurations of emotional states are possible. Moreover, it should be noted that these probabilities are not generally going to be 0 or 1 but will have an intermediate value, reflecting the likelihood that an individual will go down one or the other path in a decision.

Another way to view these probabilities is based on the value of the input. For example, a high value of Ppf, indicating that the parallel (right brain) mechanism will report a "found" condition, can depend on the actual input. A photograph of a kitten, with a low intrinsic danger, would not be likely to produce a negative reaction, even in a negatively inclined individual. However, an image of destruction or violence could produce a negative reaction in nearly everyone. Therefore, it is possible to assign a sensitivity or transfer curve to each transition and, thus, reflect each individual's likelihood to judge one way or the other in terms of a response curve, including whether the evaluation is done.

The authors will leave it to a future article to develop a quantitative model more fully based on such transition probabilities.

SUMMARY

In summary, the authors have presented a conceptual approach that integrates current neurophysiological and social-interactionist thinking. Their integrative model offers a context and foundation for procedural approaches that take full advantage of neuroscientific insights when applying assessments and interventions in the mental health domain. This approach is further amenable to a quantitative analysis and can be explored using a variety of clinical assessment tools. This approach is based primarily on function rather than on symptoms or diagnoses. Symptomatic behavior and internal experience, as well the emergence of diagnostic categories, can also be incorporated into this model. Such incorporations can lead to a model that emphasizes an understanding of clients' states and processes in a diagnosis-free manner and can inform the clinician about which specific interventions or medications may be appropriate. The authors anticipate the development and refinement of assessment techniques as well as treatment alternatives that take full advantage of understanding clients' underlying processes, because they give rise to both internal experience and external behavior.

Among the specific benefits that the authors anticipate is a classification system that is more than descriptive. By categorizing individual traits, predispositions, and responses to stimuli in terms of this type of model, the authors can begin to identify emotional and behavioral patterns and fit them into specific excesses or deficits in the model's key parameters. This approach takes advantage of the distinction between the brain and the mind in that primary causal mechanisms are ascribed to the physical plane, whereas subjective experience is associated with a realm that is supervenient to the physical plane. The physical plane thus informs but does not entirely determine or specify the mental events that are associated with it. Whereas clients are understood to be organisms that must follow certain chemical, physiological, and information-based rules, their subjective worlds are treated in concert and used to help validate interventions. At one level, all interventions are physical, being mediated by sound, light, and so on. The authors' analysis allows a complete cycle of response, planning, and behavior to be described on this basis, which has an overall humanizing and empathizing influence. This result should help to open the clinical door to practices that are increasingly based on neuroscientific evidence and that provide constructive approaches to understanding and helping clients with mental, emotional, and behavioral challenges.

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