Some Thoughts about Feelings: A Study of the Role of Cognition and Emotion in Polygraph Testing

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When I was a child, I spoke and thought and reasoned as a child. But when I grew up, I put away childish things.

1 Corinthians 13:11 New Living Translation (2007)

Abstract

This manuscript is offered as a follow up to the work of Khan, Nelson and Handler (2009) that discussed emotion in psychophysiological detection of deception (PDD) testing. Our intent is to offer the interested reader a more in-depth discussion of the "cognitive appraisal theories" of emotion (Scherer, 2001) in hope of generating thought, debate and research. Our work here focuses on emotion, with the goal of expanding our profession's knowledge, vocabulary and appreciation of this complex concept. We suggest that emotional states, along with cognition and behavioral learning, work synergistically to create or produce measurable responses to stimulus questions during PDD testing. We further suggest that our subjects appraise or evaluate the test questions against some type of goal that is at stake, and that these appraisals serve a mediating function for valence and salience of emotional and physiological response. We will offer descriptions of how these appraisals intertwine and connect in the moment, or result from a reinstatement of a previous evaluated conflict. Our paper scaffolds on the Khan et al. (2009) work by integrating the writings of many modern emotional researchers whose works are listed in the reference section.

Describing versus *defining* emotion

We find ourselves at a loss for locating a universally accepted definition of the word *emotion*. One reason for this is that definitions are generally used to describe tangible things or processes that can be observed. They do not include the need to describe systems before being able to describe what those systems do, as in the case of emotion. We will provide a basic concept of the constituent parts of an emotion, and then attempt to construct an explanation of emotion from that foundation. This description will be an amalgamation of the writings of several psychologists in the area of emotion research (Averil, 1994; Barlow, 2002; Bradley & Lang, 2000; Clore & Ortony, 2000; Coleman, 2001; Damasio, 1999 & 2000; Gray, 1994; Lane, Nadel, Allen & Kaszniak, 2000; Lazarus, 1994, 1991; Le Doux, 1994, 1996, 2000; Power & Dalgleish, 2008; Scherer, 2000; Scherer, Schorr, & Johnstone, 2001). We make no claim as to have encompassed all of the current offerings of what constitutes emotion, which would require a monumental effort. Rather, we attempted to include those aspects of modern writers that seem to aptly describe the interactions that are *most likely* observed during PDD testing. As with most discursive attempts to account for the inner workings of the mind and subjective experience, we place an emphasis on cognitive contributions to reason to our conclusions.

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Different emotional models / theories

We begin with an overview of many of the existing theories of emotion in current literature. Since there are many ways in which one could study what role emotions may play during PDD testing, we would be remiss to attempt such a study or discussion without consideration for the breadth and depth of existing work in the broad field of psychology. Scherer (2000) lists the following as some of the current psychological models of emotion:

Dimensional emotion models place their major focus on subjective feelings and categorize emotions based on such concepts as valence (positive or negative value) and arousal. *Uni*-dimensional models (Duffy, 1941; Watson, Clark & Tellegan, 1988) stress the idea that one dimension is sufficient to distinguish emotional states. *Multidimensional models* (Plutchik, 1962; Russell, 1980) stress two-dimensional models assessing valence and activation. *Discrete emotion models* (Gray, 1990; Panskepp, 1982) include circuit models and basic emotional theories (Plutchik, 1980). *Circuit models* (Gray, 1990; Panskepp, 1982) approach understanding emotion by attempting to elucidate the neural circuits underlying the responses. Basic emotional theories suggest there are a limited number of core emotions that have developed over the course of human evolution. Each of these basic emotions has an associated antecedent or eliciting set of conditions and each has a specific response pattern. *Meaning oriented models* include lexical (Ortony, Clore & Collins, 1988) and social constructivist models (Averill, 1980; Harre, 1986; Shweder, 1993). *Lexical* approaches (Ortony, Clore & Collins, 1988) attempt to understand emotions using semantics to label emotional states. *Social constructivism models* (Averill, 1980; Harre, 1986; Shweder, 1993) claim socioculturally determined behavior, expectations and values impart the meaning that in turn generates emotional states.

Finally, we come to *componential models* (Ellsworth, 1991; Frijda, 1986; Lazarus, 1991; Roseman, 1984; Scherer, 1982) or *integrative models* (Barlow, 2002) that attempt to study emotion as a system of integrated components. These theories recognize that the complexity of emotions and emotional theories cannot be explained or understood by isolating them to a single field of study. A number of modern theorists now approach the study of emotion from an integrated perspective, one that includes affect, behavior, neurobiology and cognition (Barlow, 2002; Ellsworth, 1991; Frijda, 1986; Lazarus, 1991; Roseman, 1984; Scherer, 1982).

Emotional syndromes, states and reactions

We found the foundation Averill (1994a) provided for understanding the concept of emotion helpful, where the terms emotional syndromes, emotional states and emotional reactions all apply to emotion but in different ways. Having a definition of each will provide a common framework for our discussions.

Emotional *syndromes* are the hypothetical concept of what it means to experience an emotion, and the term *syndrome* refers to an expected pattern of co-occurring signs or symptoms that may indicate a common origin (Coleman, 2001). Emotional syndromes are what we think of when we "picture" an emotional state.

Emotional *states* are episodic experiences in the form of a short term disposition to respond in a manner consistent with the expectations of the equivalent emotional syndrome. In other words, emotional states are the condition we find ourselves in while experiencing an emotion and occur in response to a stimulus event. We will use the terms emotion and emotional states interchangeably throughout this paper.

Emotional *reactions* are responses to the emotional state. Emotional responses are characterized by the presence of four major components: a cognitive component, an affective component, a biological component and a behavioral component (Barlow, 2002; Bradley & Lang, 2000; Damasio, 1999 & 2000; Lazarus, 1991; Power & Dalgleish, 2008; Scherer, 2000). The cognitive component accounts for the conscious or unconscious perception and appraisal of the stimulus in terms of emotional significance or meaning to the subject. The affective component provides the subjective experience or feelings associated with a particular emotion, which humans and other animals have historically used to increase learning and enhance survival (Buck,

2000). The biological component includes the bodily effects resulting from activation of the autonomic and central nervous system. Finally, the behavioral component provides the impetus to engage in action or behavior, and is often the most useful point of observation when we seek to understand a person's motivation and goals. Emotional reactions result from a complex, integrated pattern of central and autonomic nervous system functions which manifest themselves in physiological response patterns and are intended to create circumstances that are advantageous to the organism. They are a product of evolution that have their biological origin in the brain, but use the body as their stage.

Emotionality in the polygraph context

Emotionality is the measurable aspects of behavior resulting from emotion (Reber, 1995). During PDD testing we attempt to differentiate truthfulness from deception by assessing reactions to test questions and then making inferences about the salience of the questions from those reactions. Some of the changes we consider in PDD testing are likely the result of emotional states, which are also dependent on motivation, experience, memory, and cognition. Some of the physical manifestations of emotionality, as observed during PDD testing, include changes in respiratory, cardiovascular, vasomotor, and electrodermal activity. PDD testing theories hold that observed emotionality associated with the test question will contribute to the physiological reactions that can be measured and interpreted. We should be reminded at this point that we will never know, nor can we assume to know, precisely what emotion or emotions our examinees experience during PDD testing. Individual emotions are semi-predictable events that are assumed to be the direct result of the PDD test questions, but may vary depending on who is being tested (personality), why they are being tested (pre-employment, sex offender, event-specific criminal test), question type (relevant, probable-lie comparison, directed-lie comparison, or neutral question), or veracity status (truthful or deceptive). Though currently we cannot identify the particular emotions measured during a PDD exam, there is no dearth of research to support PDD's ability to separate truthfulness from deception well above chance and quite reliably (National Research Council, 2003).

Purpose of emotions

Emotional states are the result of evolutionary fine-tuning that is intended to ensure the survival of an organism (Smith & Kirby, 2001). This is accomplished by preparing and motivating the individual to contend with goal relevant stimuli, like PDD test questions. First, emotions serve to produce responses that enhance survivability of an encounter (Damasio, 1999; Ekman & Davidson, 1994a & 1994b; Lazarus, 1991). Emotions can be seen as mechanisms that regulate behavior in relation to patterns laid down through evolution.

Cannon (1927) described fear reactions as an overall sympathetic nervous system (SNS) arousal resulting behaviorally in what he called *fight-or-flight*. When presented with an emergency situation, Cannon felt an animal can choose to fight the danger or attempt to flee. Fighting and running away both involve an initiation of movement, where immobility is just the opposite. Alternatively, Gray (1988) introduced the term Behavioral Inhibition System (BIS) to describe a series of responses to fear stimuli that include increases in arousal, behavioral inhibition, and increases in attention. The *freeze* response became an integral part of Gray's early BIS hypothesis and described an inhibition of ongoing behavior. Updated descriptions of the BIS by Gray and McNaughton (2003) discussed behavioral inhibition as decreased motor activity when presented with fear or anxiety associated with an approach-avoidance based conflict. The updated theory separated pure "freeze" reactions, which were typically associated with the fight or flight response, from those that were behaviorally inhibited. This introduced the concept of higher brain functions being able to override programmed behavior. Such adaptive capabilities would serve to expand a response repertoire, thus increasing the chance for survival.

Gray and McNaughton (2003) noted that the freeze response and behavioral inhibition were physiologically so similar that they were very difficult to differentiate, especially in humans. The difference between

the two in the causation of arousal was conceptualized as a difference between freezing proper and a defensive quiescence, or quieting. The freeze response (freeze proper) occurred when an animal was placed in the immediate proximity of a highly fearful stimulus and was followed immediately by a fight or flight reaction. Additionally, this freezing proper was insensitive to anxiolytic drugs and could be triggered by learned or innate stimuli. They noted that the freeze proper response functions in a manner similar to the startle response; it quickly disconnects the animal from ongoing behavior allowing it to attend to more important and immediate stimuli. Behavior inhibition, on the other hand, involved attention with an emphasis on evaluation in the form of a *stop-look-and-listen* action. Behavior inhibition is said to result from anxiety and was *inhibited* by anxiolytics (Gray & McNaughton, 2003).

An additional biological function of emotions is to prepare the organism for a reaction, often in the form of a physical action, even though a reaction may not be needed and may not occur. Emotions, however, allow a head start towards a reaction, where a number of physiological changes will occur in anticipation of a potential negative encounter. This feed-forward type of physiological preparation is referred to as *allostasis* (Berntson, & Cacioppo, 2007; Handler, Rovner, & Nelson, 2008; Schulkin, 2003; Sterling, 2004; Sterling & Eyer, 1988). Allostasis can be described as a central nervous system mediated, integrated brain-body response geared towards viability or survival. It occurs in regulatory systems which have no fixed set point and all are the result of evolutionary tinkering. The evolutionary benefits of adopting a "Why wait?" response seems obvious.

Discrete versus component-process theories of emotion

Emotion literature is replete with arguments for and against the idea that there are "basic" or discrete categories of emotional syndromes. It would be an understatement to write that many well respected researchers have conflicting opinions about the existence of a prototypical core of emotion states and reactions (Ekman & Davidson, 1994a). Add to that the fact that there are conflicting definitions of what constitutes a *basic* emotion (Averill, 1994b), and we can begin to appreciate the ambiguity surrounding this concept. A number of researchers have agreed that in order for an emotion to be considered "basic," it must be able to be distinguished by distinct universal components, such as facial expressions, or have distinct physiological components (Power & Dalgleish, 2008). Power and Dalgleish (2008) made a cognitive case for distinguishing among emotions using the perceived appraisal as that which gives an emotion its distinctiveness. A number of discrete emotion theories suggest that these basic emotions can mix or blend to produce a variety of emotional states (Scherer, 2001). This approach, however, is rooted only in theory for the time being because it would involve testing mental states (appraisals) as opposed to physiologic arousal.

Khan et al. (2009) used the concept of basic emotion theory as a starting point for understanding emotional contributions to PDD testing, as there seems to be sufficient face validity for it to be considered plausible. They pointed out that among the diversity of lists of basic emotions, investigators have found evidence for six; fear, anger, happiness, sadness, disgust/contempt, and surprise. Several researchers point out that surprise does not always result in an emotion, and have dropped it from the list. They link surprise to the startle reflex and point out it is not indisputably an emotion state. Khan et al. (2009) and Power and Dalgleish (2008) listed those emotions that are listed in Table 1 along with their accompanying appraisals.

We want to take a moment and discuss fear and anxiety as they may relate to PDD testing. When discussing anxiety, we refer to state-anxiety, or that anxiety which occurs in a short-term phasic manner. This is not to be confused with trait anxiety which is a relatively stable characteristic of anxiety in a person. Fear and anxiety are sometimes used synonymously though their relationship has often been debated (Barlow, 2002). Many times it requires a set of semantics or a definition to clarify or settle any debate. The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV TR) is published by the American Psychiatric Association and provides diagnostic criteria for mental disorders. The current DSM-IV states the term anxiety

Table 1. The key appraisals for each of the five basic emotions, adapted from Power and Dalgleish (2008).

Basic Emotion	Appraisal
Anger	Frustration or perceived blocking of a role or a goal, directed at the perceived thwarting agent
Fear/Anxiety	Physical or social threat to self, goal or ego-type
Disgust	Something repulsive to oneself or society.
Sadness	Actual or potential loss or failure of a valued role (ego-type) or goal.
Happiness	Positive move towards a valued goal (ego-type) or role.

denotes "apprehension, tension or uneasiness that stems from the anticipation of danger…". Ohman (1993) called anxiety "a state of undirected arousal following the perception of a threat," which seems to fit some of what we may observe during PDD testing. Epstein (1972) suggested fear relates to action potentials such as fight-or-flight while anxiety occurs when those action potentials are thwarted or prevented. Power and Dalgleish (2008) provide another description of anxiety that fits the PDD testing milieu. They propose that anxiety

> "…is conceptualized as a state in which the individual is unable to instigate a clear pattern of behavior to remove or alter the event/object/ interpretation that is threatening an existing goal."

Again, from a PDD testing point of view this provides a plausible explanation for a portion of the emotionality we may be observing.

Contrary to a discrete emotion theory, the component process model (Scherer, 1984b) does not assume there is a set of hard-wired programs that mix or blend to produce a variety of emotional states. Rather, the component process model suggests that continuously changing patterns within the emotional components results in a large number of different emotions. Scherer (1984b) refers to these as "modal" emotions and writes they are potentially infinite in the possible combination of resulting emotions, though acknowledges there is some "bunching" of these elements around the "basic" emotions.

Ekman (1994) offers a possible middle ground for this argument under the concept of "emotion families." Each emotion is not itself a single affective state, but belongs to a family of states. These families share a number of characteristics that vary to produce individual differences based on the appraised circumstances. Any resulting emotion can be a variation of a theme, reflecting learning. Multiple variations of multiple themes can occur simultaneously.

The advantage of consciousness for our emotional reactions

Consciousness of emotions can be seen as adaptive responses to allow organisms a greater opportunity to succeed in life. Humans are gifted with extended consciousness (Damasio, 1999), which describes their ability to incorporate past memory and future planning into a current appraisal. This also allows humans to form and execute better adaptive strategies in the face of a perceived challenge to a goal. These

strategies may include a response in preparation for a potentially aversive event, as well as inhibiting a prepotent response. Having an expanded repertoire of responses would seem to endow an organism with an increased chance of survival.

We are proposing that emotion results from an evaluative process, called an appraisal, and are always therefore about something. Feelings that are the conscious perception of the affective aspect of emotions, seems to have evolved to increase the value of the emotion. Being able to remember a prior emotional encounter serves to allow the organism to respond more quickly the next time it is in a similar circumstance (Damasio, 1999; Power & Dalgleish, 2008). In order to reap this benefit, that organism is best served by being endowed with an extended conscious.

Cognition

Cognitive activity broadly describes any conscious or unconscious thought process (Lazarus, 1991) that results in the appraisal of and response to a stimulus. For the purposes of this paper, the term *cognition* will include the route by which a stimulus, or test question, is perceived, attended to, processed, evaluated, compared to memory, encoded into memory, etc. It will also include the performance of the mental computations commonly referred to as *thinking*. Recent neuropsychological models have supported the notion that, at least in humans, emotional and cognitive functions are strongly reciprocally connected (Gainotti, 2000). We will make no attempt to discuss emotion outside of this relationship, lest we risk a semantics struggling match.

The Lazarus (1991) description of emotion from a *cognitive-motivational-relational* perspective applies easily to the PDD setting. Cognition can mediate a shift in attention from what was occurring to something new and can include planning and coping mechanisms. Motivation, which is essentially what we want, determines the power of the particular emotion as the encounter is appraised in terms of goals. Motivation can also be influenced by the valence (positive or negative value) of an emotion. The relational aspect of the Lazarus (1991) theory accounts for the idea that all emotion is a response to a person-environment relationship appraisal. The term environment here is used to describe anything the person may interact with that can result in an emotion. Lazarus (1991) discussed relational terms as either positive or negative emotion generating, depending on how the relation is appraised with regard to goal relevance, goal congruence or incongruence, and type of ego-involvement (Lazarus, 1991). He also offered the idea of secondary appraisals which are related to coping potential, agency (who is to blame) and future expectations. For example, if a person assesses the person-environment relationship to be harmful, goal incongruent, or have negative adaptational consequences, a negative emotion would likely be elicited with accompanying negative affective qualities. Conversely, an appraisal of a goal congruent relationship would foster an emotion that has a positive valence.

The appraisal process is not a one-shot circumstance where a stimulus is evaluated with regard to goal relevance, implication and coping potential, and a single response generated. Lazarus (1991) and Scherer (2001) point out the initial appraisal is followed up by multiple iterations of reappraisals. These reappraisals serve to update the organism on changes in the circumstances so that any appropriate adjustments, up or down, may be made. A series of "evaluation checks" are occurring in an ongoing manner as the signal terminates through extinction or is supplanted by a more salient stimulus (Scherer, 2001).

Cognition in the polygraph context

During PDD testing, examinees are presented with a number of stimuli, in the form of test questions, and are essentially asked to attend to each sequentially. Presumably, as the examinee attends to each test question he or she conducts an appraisal with respect to what that test question means. This appraisal relates to the examinee's goals, standards, and attitudes and how those may be affected within the PDD setting. Cognition and appraisal are a process of evaluating a stimulus for goal congruence within the examinee's motivational framework. While it is not feasible to attempt to state we know what

particular meaning a particular examinee attributes to an individual test question, it is possible to discuss a number of possibilities of what the examinee could be thinking in terms of goal congruence. Appraisals are simply an evaluation that are assigned emotional meaning, value or salience (Barlow, 2002; Bradley & Lang, 2000; Clore & Ortony, 2000; Damasio, 1999; Gray, 1994; Lazarus, 1991, 1994; Le Doux, 1994; Le Doux, 1996; Le Doux, 2000; Power & Dalgleish, 2008; Scherer, 2000).

How do appraisals result in emotional states?

We have suggested that emotions are the response to appraisals of significance in a given situation with respect to goals. We offer that there are two routes of appraisal through which emotions may occur, and both are applicable to PDD testing. Both routes of appraisal involve a cognitive component and are equally capable of eliciting an emotion. One is a conceptual, computational or schematic route and the other is a reinstatement of a previously learned or evaluated situation (Power & Dalgleish, 2008). The former will be developed or computed through a situational analysis. The latter relies on memory of an earlier response and produces a faster, though potentially less accurate response. In either case, a situation that is appraised as having significance for a person's goals can elicit an emotional reaction either as a result of a reinstated prior emotion or because the person has perceived the situation to be one that will affect their goals.

A PDD related example of a conceptual, computation or schematic route for generating an emotional state.

This route of appraisal describes one that is essentially pieced together in a conceptual or story-like manner. In this case the appraisal is being conducted as the pieces of information become available. For example, take an examinee in a public safety pre-employment screening polygraph test that has been less than forthcoming about his past criminal activities. During the pre-test discussions of these issues he or she silently compares their personal involvement in criminal activities against what they believe are societal norms or what the hiring agency will accept. He or she concludes that telling the complete truth about what they have done may be incompatible with the hiring preferences of the agency to which he or she has applied. They may believe that in order to continue in the hiring process they must lie about these acts or minimize their admissions. This deception may then result in the activation of one or more emotional responses, all of which are in response to an appraisal. Perhaps the examinee is angry with himself or herself for having done these things, considering them stupid. Alternatively, they could be angry with the hiring agency for inquiring into what he or she feels is a private matter, or one that may have happened long ago and should no longer be relevant. He or she may feel some level of guilt for what they have done or possibly experience some degree of shame or embarrassment at the prospect of the polygraph examiner and hiring agency discovering this issue. There may also be some anxiety, or even fear, surrounding the idea of not getting the job or being labeled as someone who is not qualified for the job, thus ending their law-enforcement career. Some of these emotions could have occurred because, during the appraisal process, the examinee became concerned that past acts are incongruent with the goal of obtaining the job. Other emotions could result from the examinee being reminded of past trans-gressions which are socially objectionable. This is just one possible example of the multitude of ways the examinee could use a bottom-up or constructive approach to generate the emotional states.

A PDD related example of an associative route for generating an emotion state.

Imagine you are at the dentist having a cavity filled and the anesthesia is ineffective at masking the pain of the drill. As the dentist drills into your molar you experience a sharp pain coinciding with the sound of the drill. You hope your reaction to the pain will cause the dentist to stop and remedy the situation. But what about the next time you hear the sound of the dentist drill? It is possible that the sound of the drill would produce not only a cognitive response in the form of a memory, but may also result in an associative emotional reaction? This is an example of reinstatement of memory from an earlier-formed evaluation which generates emotions

"as if" an appraisal is occurring. The appraisal and the emotion should not be confused for being the same thing. The appraisal work has already been done and the memory of the appraisal has been stored for this stimulus, allowing the emotion to more quickly and more reflexively occur. One need not stretch his or her imagination to appreciate the evolutionary benefits of such ability. Long term survival would seem more likely in an organism that does not have to perform a complete appraisal before generating an emotion and action in response to a threatening event. One that can activate responses because of a memory of a similarly appraised encounter can act faster and perhaps respond more effectively. In its extreme form, this feature of physiology results in pathological formations. In the case of Post Traumatic Stress Disorder, a person's reflexive cognitive, emotional, and physiological responses do not contribute to survival and effective response to the present environment, but rather, actually interfere with effective functioning.

Another example that offers a potential for a reinstatement of an emotion is the negative social connotations associated with lying. It is important to recognize that lying is both goal-directed and a common behavior, intended to reduce anxiety or threat associated with the truth about information for which a lie is told. This may occur in part because people are social creatures who often tend to seek approval and acceptance of their fellow humans, though they sometimes lie to achieve these goals. Most children are socialized from an early age to equate honesty with honor and goodness, that dishonesty is frowned upon, and that lying brings about punishment. We recognize that sometimes lying can also bring about reward when the deceptive behavior is not confronted. The decision to lie rests in the appraisal of whether lying will produce less internal anxiety or external consequences than would telling the truth. While lying is almost universally disapproved of, children are also socialized to understand the subtle boundaries surrounding verbal discretion, social politeness, and obsequiousness. In most societies lying in formal settings such as in discussions with a person in a position of authority is strongly discouraged, and in some cases, such lying is punished severely when it is discovered. For example, lying to a federal law enforcement officer during the course of an investigation is a felony in itself. It would seem there is a potential for anxiety to be associated with openly breaching such societal rules. There is also the potential for positive and conflicted emotions as the person hopes and seeks to obtain a desired result through telling a lie.

The act of having lied, for some people, may cause the test questions to function as a form of conditioned stimuli. Test questions pertaining to the act about which the examinee lied can produce a learned or associated internal anxiety state. This anxiety state is a consequence of a lifetime of conditioning experience resulting from accepting and rehearsing a system of socialized values that emphasize goodness and honesty. The possibility of getting caught in a lie and/or the punishment associated with being caught can generate a negative emotional state. Thus, even in a laboratory setting (where there is little jeopardy) the act of lying may create sufficient emotionality or conflicted response to produce measurable physiological reactions. Similarly, conditioned responses and any associated emotional states stemming from the behavioral act itself, independent of the act of lying about the event, may also play an additive role in the development of observable and measurable polygraph reactions, along with related neurobiological activity and mental effort.

Cognitive processes surrounding knowledge and memory of having engaged in an act can increase the salience of a test question about that act. Pretest discussion and review of the test question is thought to increase the salience of the test question for a person involved in the event, by stimulating thoughts, memory, and emotional experience pertaining to the event. Persons uninvolved in the event described by the test question have no associated memories, thoughts or emotional experience regarding the details of the incident. The memory tasks involved in lying can require additional mental effort or increased cognitive load. The subject must attempt to suppress a memory or thought and divert their attention to another matter when presented with the test stimulus question. Liars need to create their lie, assess that lie with regard to plausibility or believability,

keep the lie straight during possibly numerous retellings and not confuse the lie with the truth. Liars also need to keep the lie separate from the truth and they need to monitor themselves more carefully in order to ensure they appear truthful and avoid giving away the falsehoods. In addition to the need to marshal sufficient mental ability to manage the content complexity and tell the lie in a convincing and coherent manner, liars must also try to conceal any emotional reaction which may occur in response to either the event or the act of lying. This content complexity (Vrij, 2008) can add both emotional stress and cognitive demands to task requirements for dishonesty compared to similar requirements for truth telling.

A truthful person, uninvolved in the event described by a polygraph question, is free of the burden of conditioned emotional responses to the act of lying and to the event described by the relevant questions. This person is also free of the complex demands on attention and cognitive systems, including any need to manage presentation or appearance while maintaining a separation of the truth from the development and presentation of a plausible alternative. The truthful examinee may devote attention and effort to assess the likelihood that the test will result in an error, and the potential consequences associated with an error. However, our position is that the emotional and cognitive demands relevant questions place on the truthful person are less than those required of someone who is involved in and chooses to lie about an event under investigation. The effectiveness of PDD stimuli would seem to be contingent upon whether there is reference to both an event in question and the examinee's involvement in that event. For example, someone being investigated for a bank robbery might be asked, "Did you rob that bank?" This manner of questioning would more directly associate the examinee with the act of concern than would an indirect approach involving questions about lying, in person or in writing, regarding the event in question (e.g., Were you truthful in your written statement about not robbing the bank?). We know from conditioning studies that the closer a stimulus is to the conditioned target stimulus, the larger the reaction (Kehoe & Macrae, 2002).

Emotion-Specific Physiology

The issue of whether there are distinct physiological measures specific to "an" emotion has been contemplated and investigated for some time. William James (1890) felt emotions were the result of specific changes in skeletal muscle and other physiological changes that were read out to create each emotion. The notion that peripheral physiological measurements could parse out individual emotions began to be replaced by the Schacter and Singer (1962) two-factor emotional theory. Their theory emphasized that the cognitive factors were the main determinant of the specific emotion which resulted in a general state of arousal. Advances in instrumentation may have contributed to a renewed interest in psycho-physiological differentiation among discrete emotions in recent years (Davidson, 1994).

Several experiments have attempted to find differences in autonomic nervous system (ANS) arousals. Sinha, Lovallo and Parsons (1992) found systemic differences among some emotions which have negative valence. Anger resulted in greater diastolic blood pressure and increased peripheral resistance when compared to fear. Levenson, Ekman and Friesen (1990) compared anger and fear using finger temperature and reported an increase in temperature for anger and a decrease for fear. Cacioppo et al. (1993) conducted an extensive review of studies comparing two or more emotions measured by two or more ANS responses and reported finding little consistency. Cacioppo, Petty, Losch and Kim (1986) reported increased electromyographic activation of corrugator muscles during negative affect stimuli and great activation of zygomatic activity with positive affect stimuli. Levenson, Ekman and Friesen (1990) reported the finding of four reliable differences among the negative affect emotions of fear, anger, sadness and disgust. They found: (a) anger produced a greater increase in heart rate when compared to disgust; (b) anger produced a greater increase in finger temperature when compared to fear; (c) fear produced a greater increase in heart rate when compared to disgust and (d) sadness produced a greater increase in heart rate when compared to disgust.

As Khan et al. (2009) point out, these findings suggest a weak support for an ability to differentiate specific emotions using ANS measurements (Davidson & Ekman, 1994; Levenson, 1994a & 1994b). From a PDD standpoint, this may seem like gloomy news if we were to be claiming to be able to pinpoint "fear" from among the many other potential emotional states an examinee may experience. Fortunately, a fear alone driven theory of PDD testing, is untenable. We suggest we do not know, and could not know, what specific emotion or emotions may be contributing to ANS changes we measure during PDD in any particular individual. Instead, we are content to admit that whatever contribution emotion makes to changes in our measurements, it is sufficient to allow us to effectively differentiate truthfulness from deception.

A review of relevant, probable lie comparison (PLC) and directed lie comparison (DLC) questions in PDD testing.

In investigative polygraph testing, relevant question targets are dictated by the circumstances of the investigation and are commonly formulated around the most salient or intense aspects of the allegation. In screening programs, relevant questions should describe the test subject's involvement in possible behavioral concerns to risk managers or adjudicators and should be designed to add incremental validity to their particular program. Effectively formulated relevant questions will directly assess the test subject's behavioral involvement in the issue of concern.

PLC questions are presented to the test subject as being necessary for further evaluating the test subject's character and the issue under investigation. PLC questions are based on transgressions whose subject matter is generally or conceptually related to the allegations of the examination and which virtually all persons may have committed, but will likely be denied in the context of the examination. PLC questions are broad in scope and the test subject is strongly, but indirectly, discouraged from making admissions to PLC questions. If the test subject makes an admission to a PLC question, the examiner typically addresses that admission with some dismay, minimizes the admission, or modifies the comparison question accordingly. The ultimate goal is to discourage admissions to PLC questions to ensure that the test subject perceives them as ambiguous and broad in nature. It is also important the examiner imply to the test subject that lying to any of the questions (relevant or PLC questions) will result in a failure of the polygraph test and resulting conclusion of deception to their involvement in the relevant issue under investigation.

DLC questions are those which the examiner instructs the examinee to answer falsely (Honts & Raskin, 1988; Raskin & Honts, 2002). DLC questions are presented to the examinee as necessary to ensure they maintain an ability to respond appropriately when lying. Examinees are told that if they fail to respond appropriately to the DLCs, the test result will be inconclusive. The rationale being that most truthful subjects will view an inconclusive result negatively.

DLC questions may offer some relief to potential problems identified in PLC versions of polygraph testing. Examiners may experience difficulty in standardizing comparison questions in the PLC version. Each test subject brings his or her own life experiences and idiosyncrasies that may sacrifice rapport while attempting to lay a foundation for the PLC questions. Additionally, test subjects who have prior polygraph experience or those who have researched polygraph techniques may not be naïve to the PLC principles. This sophistication could make laying the foundation for the comparison questions challenging. Non-naïve test subjects may acquiesce to the procedure in order to not seem obstreperous, in which case the PLC questions become similar to DLC questions.

One theory behind the DLC approach is that it is similar to the PLC approach in that it is assumed the subject's cognitive and emotional attention will be focused more on the questions that pose the greatest concern of not passing the test, which should be a goal of most test subjects. Thus, the truthful subject will be more concerned with whether or not they are a suitable subject and whether or not they are producing appropriate responses to the DLC questions when they are lying. Though they have permission to lie on these questions, the questions still serve to

draw the examinee's attention during testing to the questions that pose the greatest challenge to achieving their goal. The theory further proposes the guilty subject will remain primarily concerned about the relevant questions on the test and will consequently produce the greatest reactions to them. In this sense, the DLC questions operate as a distracter item for the truthful subjects, who are more capable of being distracted away from the relevant questions than are the deceptive subjects.

Conclusions

We have attempted to build on the work of Khan et al. (2009) for the reader interested in a deeper understanding of the concepts they offered on cognition in emotion. We chose to focus on emotion and sub-focus on a cognitive appraisal structure of emotion in hope of expanding our profession's knowledge, vocabulary and appreciation of this complex concept. Our hope is that others will continue these investigations, focusing more on cognition and its inter-relationship with motivation and behavior. We proposed that emotional states, along with cognition and behavioral learning, form a constellation of response potential that produce measurable responses to stimulus questions during PDD testing which may be used to accurately and reliably categorize subjects as truthful or deceptive. We further suggested that the test questions in the PDD setting are perceived by the examinee and cognitively appraised with regard to goals, standards and attitudes, as well as coping potential, agency and future considerations. These appraisals serve a mediating function for salience of emotional states and their concomitant physiological response. Following the suggestions of Khan et al. (2009) we feel the appraisals can be generated in a schematic manner or via a reinstatement of a previous evaluated conflict and we offered a parallel between each mode of generation in a hypothetical examination setting.

We feel it is important to reinforce at this juncture the potential complications involved in PDD testing and how those complications may work to the detriment of specificity to deception. Many things can result in arousals that are not specific to deception. By considering the ways that reactions can be caused during PDD testing we may be in a position to strengthen specificity. PDD testing depends on the evaluation of the examinee's physiological reactions to test questions, and then works backwards to make inferences about whether the examinee's reactions correspond to expected responses from truthful or deceptive persons. The success of these methods depends, in part, on the assumption that the primary thing which differentiates response magnitudes to various stimuli is the degree of salience which the examinee assigns the test question. The specificity of that salience is revealed through the degree of physiological reactions. Differential reactivity is presumed to occur in response to the examinee's cognitive appraisal, memory, behavioral experience, and emotional response regarding the test stimulus questions. The complexity of these physiological systems and assumptions will inevitably prompt discussion about the potential for error in the PDD context. Our ultimate confidence in the viability of PDD testing as a method for credibility assessment and the challenge of differentiating truthful from false statements is ultimately dependent on empirical evidence, and the substantial body of field and laboratory research that supports the validity of PDD testing (Honts, 2004; Raskin & Honts, 2002).

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