Emotion, Attention, and Decision Making: Their Interaction, and Potential Impact on Deception

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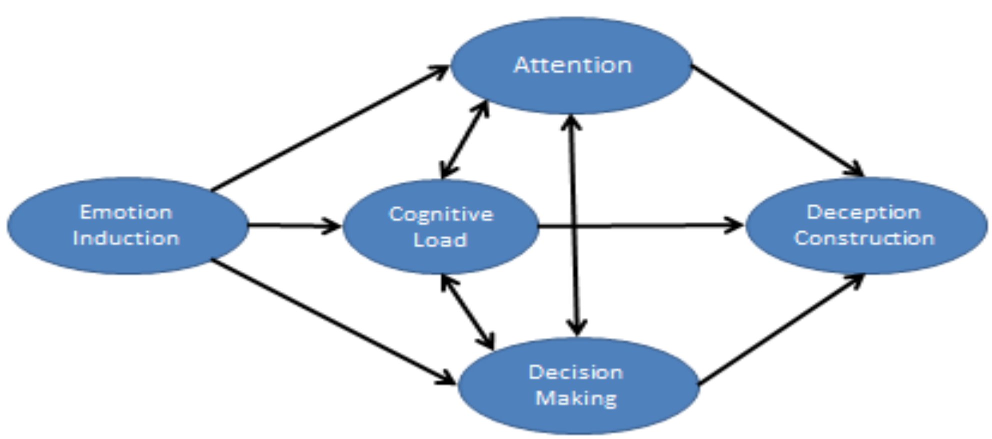
Abstract

The induction of emotional states produces significant effects in other domains of cognitive processing. Emotional experiences affect attentional mechanisms, decision making capability, and can impose considerable strain on mental resources under the rubric of cognitive load. Successfully constructing a deception involves several steps, including the allocation (and focusing) of attention, and other cognitive activity associated with decision making. The goal of the present work is to seek a clearer explanation of how emotion ultimately impacts deceptive behavior. The proposed model traces a path from emotional induction through attention, decision making, and cognitive load, through a discussion of the potential facilitative or detrimental effects (of emotional experiences) on the ability to deceive.

Introduction

Human behavior is suitably envisioned as arising from a dynamic interplay between systems. Accordingly, both neuroscientific and cognitive evidence frequently serve to account for the apparent nature of observable systemic interaction. The present work outlines a multi-stage relationship between emotional processing and the (ultimate) ability to construct a deception, contending that emotion influences one's ability to deceive by impacting several systems prior to the output of lying. I will make the case that emotional processing affects attentional resources (generally), specific phenomena associated with resource-limiting constraints of cognitive load, and aspects of decision making ability, by using a 'levels-of-analysis' approach to detail the putative path from emotion induction to deception construction. Research examining the major theoretical constructs individually (and potential relationships between systems) will demonstrate the putative phasic progression from creating an emotional state to deception production. A graphical depiction of the current model under consideration follows directly below.

The Integrative Model



I. Defining 'Emotion'

Some suggest that rigorous, consensus agreement on terminology is an unnecessary first step for the scientific study of behavior-based constructs (Pessoa, 2013). A chief contention of that argument rests in the idea that exploratory research often guides the revisionary process of defining terms; at least, more frequently than the reverse. Acknowledging the descriptive variability attached to the construct of emotion (Lang, 2010), it appears to remain beneficial to impose at least some conceptual outline for its investigation. Thus, Kolb and Whishaw (2009) provide a sufficient depiction of the idea: a state of mental excitement characterized by alteration of feeling tone, and by physiological and behavioral changes. This 'working' definition of emotion informs the subsequent discussion on both the time-course of emotional experiences, and the neural networks involved in relevant processing.

Appraisal vs. Automaticity

Whether automatic or controlled (appraisal-based) mechanisms guide human emotional processing generates considerable scrutiny among researchers. Classically, William James's stance allowed the possibility that occurrences of emotion could indeed be immediate. The insistence that rapid 'bodily changes' accompanied emotions strongly implied this notion (James, 1892; Deigh, 2014); the instantaneous autonomic reaction associated with fear when unsuspectingly confronted by a bear is perhaps the most repeated example. Recently, accounting for emotional experiences in terms of automatic processing continues to receive support. Using magnetoencephalographic (MEG) measures, Luo et al (2010) demonstrated early (40-140ms) amygdalar responding to the presentation of emotionally-laden stimuli (human faces). They interpreted the results as activation that occurred independently of attentional awareness. Pessoa (2013) also noted that, following the manipulation of visuospatial variables, the perception of emotion (discerned by amygdalar activity) occurs without the benefit of directed attention; the term "obligatory" describes the processing speed of certain emotionally-laden content.

Evidence from the literature on motivation and the nature of goal directed behavior also indicates the potential for automatic processing. Custers and Aarts (2005) found that the induction of emotional states (prominently, the positive type) from a baseline of 'neutral' involved elements of non-conscious processing; again, hinting that the impact of emotion occurs outside the bounds of explicit cognitive activity. Additionally, immediate processing correlates with negative emotional states. In a series of experiments investigating ties between memory and emotion, Kang, Wang, Surina, and Lu (2014) observed better retention for negatively-valenced words (part of the emotion-enhanced memory effect, or EEM) associated with automatic processing.

A competing viewpoint of automaticity materialized in the form of Arnold's (1960) idea that the experience of emotion requires cognitive evaluation (appraisal). More current work echoes the likelihood of a markedly dynamic relationship between appraisal and emotion, in the context of 'core affect' (defined along the dimensions of valence and arousal). Kuppens, Champagne, and Tuerlinckx (2012) had participants provide information on characteristics of core affect and appraisal across a series of real-time events occurring outside of the laboratory; they found an ongoing bidirectional influence. Moors (2013) also noted support for the relationship by concluding that appraisal processes act as catalysts in a cyclical progression with the experience of emotion. Khan, Nelson, and Handler (2009) proposed that appraisal (divisible into conscious and subconscious subtypes) may also serve a function in the context of facilitating goal orientation. Further, heightened awareness through conscious appraisal is thought to provide the advantage of adapting to one's environment, while concurrently affording increased interpretive power to characterize experiences (Handler, Shaw, & Gougler, 2010).

A growing number of researchers contend that the traditional framing of appraisal in mediating cognition and emotion may be an oversimplified explanation. Moors, Ellsworth, Scherer, and Frijda (2013), for example, stated the value of viewing the complexity of human emotional experiences as a function of somatic, motivational, and cognitive factors. Indeed, a general trend in appraisal-based research highlights an increasingly nuanced functional structure, inclusive of the impact (on emotion) of metacognitive confidence level (Tong, Teo, & Chia, 2014), and the influence of cognitive re-appraisal on emotion regulation (Buhle, et al 2014).

It is possibly more reasonable to describe the variability of human emotion in a mixed model involving both automatic and appraisal-based types of processing. For example, amygdalar activation occurs in response to emotion induction with and without the presence of attentional processing (Luo, et al, 2010). Further, each 'branch' of theories received criticism: automatic processing may be limited to stimulus-specific cases, such as the detection of emotion in faces (Rellecke, Palazova, Sommer, & Schacht, 2011); and, one of the notable (fundamental) flaws with appraisal theories concerned the (artificial) presumption that appraisals and emotions operate independently (McEachrane, 2009). Finally, in a review analyzing the time-course of attention and emotion-based amygdalar processing, Pessoa (2010) reiterated the prospect that successfully decoupling the two domains proves a daunting task. To gain a clearer picture of the nature of emotional processing, it is necessary to take a more detailed look at the neural representation of emotions in the brain.

Areas Linked with Emotional Processing

A complete review of brain areas underlying emotional experiences is beyond the scope of this paper; instead, a brief mention of some of the more notable regions involved follows. A wealth of evidence solidifies the amygdala as a prominent structure for processing emotional information across a wide range of contexts. Armony (2013), for example, stated that both positively and negatively-valenced auditory (voice, music) and visual (face, body) stimuli can trigger amygdalar activation. These findings were partially supported by Vrticka, Lordier, Bediou, and Sander (2014), who elicited activation from dynamic (computer-generated) facial expressions in 3-dimensional space. The amygdalae are also sensitive to 'socio-emotional' cues, even under conditions of ambiguity, portrayed by the interaction of inanimate objects (Phelps, 2006). Further, clinical evidence of double dissociation supports the integral role of the amygdala in emotional processing, as Bernston et al. (2007) observed decreased arousal to negative stimuli in patients with amygdalar damage, relative to a control group with lesions (strictly) elsewhere in the brain.

Emotional processing, however, is not restricted to amygdalar space. Work dating from the beginning of the 20th century on the physiology of emotional experiences began to implicate thalamic (and later, hypothalamic) activity (Dror, 2014); an idea that receives continued support (Hartikainen et al., 2014). Landa et al. (2013) investigated networks related to interpersonal (i.e., based on interactions with "others") vs. non-interpersonal emotions. Interpersonal emotional experiences correlated with activity in anterior and posterior cingulate cortex, the parahippocampus, medial frontal and temporo-parietal areas. Concerning motivation, the presentation of appetitive stimuli (tied conceptually to positive emotions) coincided with activation in the nucleus accumbens, and a ventral portion of medial prefrontal cortex (Lang, 2014). Functional MRI results from studies employing subliminal facial expressions demonstrated activity in temporo-parietal, inferior and dorsolateral frontal regions (Prochnow et al., 2013). Further, increased ventrolateral prefrontal cortical (vPFC) activation results in response to the display of emotional pictures; an effect which appears to strengthen across development (Vink et al., 2014).

Research also suggests insular cortical involvement with emotional processing. Gasquoine (2014) asserted that areas within the insula respond to the interpretation of autonomic information. Gasquoine also noted that clinical studies revealing abnormal volumetric (insular) grey matter levels link the anomaly to addiction, and various mood disorders. Additionally, Denny et al. (2014) found that insular activation increased in response to the repeated presentation of negative pictures, the habituation to which accompanied a strengthened connectivity with the amygdala.

Substantial evidence corroborates that emotional information processing takes place in a widely-distributed manner. A diverse array of dynamic behavioral phenomena points to brain regions that deal with emotional information. Ziaei, Peira, and Persson (2014), for example, offered evidence of activation in the insula, amygdala, and medial and lateral prefrontal areas when attention is focused on emotionally-laden content. Further, Kohn et al. (2014) demonstrated that an area in the dorsolateral prefrontal cortex may be critical for the initiation of processing tied to emotion regulation.

The Circumplex Model

Selecting an appropriate model to represent the putative structure of human emotion is an important precursor for the operationalization of potential underlying structural components. Thus, for the purpose of this project I've selected a relatively simple, well-established model to blueprint the (cognitive) processing of emotion perception. A two-dimensional 'circumplex' depiction of emotion that describes experiences simultaneously along continua of valence (pleasure-displeasure) and degree of arousal (low-high) is suitable (Russell, 1980). The two dimensions allowed bipolar representations of level of wakefulness vs. sleep (arousal), and for the inclusion of emotional valence examples from sad and frustrated (displeased), to happy and serene (pleased). According to Russell, the circumplex structure consistently emerged despite subjecting behavioral data to a number of different factor analytic, dimensional scaling methods. Accounting for emotional experiences in terms of valence and arousal successfully applies across a wide range of (both clinical and normal) samples (Kring, Barrett, & Gard, 2003).

Critics fault circumplex theorists for attempting to divide emotional experiences along spectrum-based dimensions. Haslam (1995) suggested a more appropriate characterization to include a multitude of discrete categories, and Feldman (1995) cautioned against the way participants subjectively weight the two dimensions during self-reports. The recent development of a more refined iteration of the model addresses the above concerns, allowing a greater degree of specificity in fitting attributes of core affect ("raw, unreflective" feelings). Yik, Russell, and Steiger's (2011) 12-point circumplex model permits the dynamic inclusion of external variables through maximum likelihood estimation methods, while affording an increasingly detailed path for describing emotional components that integrates prior models. Carney and Colvin (2010) provided additional evidence for the applicability of the circumplex model, demonstrating successful accommodation of a wide range of social behaviors (potentially relating more directly to the interactive aspects of deception). Kang, Wang, Surina and Liu (2014) illustrated its facilitative role for the investigating emotion-enhanced memory effects. Further, Pettersson et al. (2013) noted that the structure of the circumplex withstands complex, longer-term (~90 days) dynamic systems testing procedures modeling emotional variability and return to a 'baseline' state.

Alternative Models

Competing theorists have argued that valence and arousal (alone) are insufficient to capture the full extent of the human emotional experience, and have proposed the existence of additional dimensions. Using stimuli from the International Affective Picture System (IAPS), Jerram, Lee, Negreira and Gansler (2014) uncovered brain activation in response to manipulating a dominance aspect of processing, related to the ability to impact one's environment. Weierich and colleagues (2010), also using IAPS stimuli, varied image presentation according to familiarity, citing amygdalar activation as evidence for a separate salience (or, novelty) dimension in emotional processing.

Alternative models of emotional structure are not limited to human peer interaction. For example, Saariluomaand and Jokinen (2014) offered evidence of a bipolar 'competence-frustration' dimension, though it remains unclear if the proposed construct is restricted solely to the context of interfacing with technology. Others sought to replace dimensions in the circumplex model, substituting 'intensity' for the traditional arousal dimension (Talarico, LaBar & Rubin, 2004).

A full evaluation of multidimensional models of emotion beyond the circumplex is outside the reach of this paper. An exploration of models (with different dimensional combinations) described above holds valid interest for a later stage of investigation. Indeed, it is a repeated notion that the ideal parsing of emotional experiences ought to occur along (at least) three dimensions (Smith and Schneider, 2009). It is also questionable whether qualitative or quantitative measures are more appropriate for an accurate representation of emotional space (Backx, 2012). For the initial iteration of the current project, however, the variables of valence and arousal seem a reasonable starting point for investigating the interference of emotional processing with cognition; and ultimately, how this may impact deceptive ability. It is imperative to gain a solid understanding of the core mechanisms involved in how emotion affects cognition. The comparatively simpler structure of the circumplex model lends itself well to this endeavor, though it remains sensible that increasingly complex models of emotion might offer useful guidance for future work.

Valence, Arousal, and Neural/Biological Correlates

The operationalization of both valence and arousal frequently manifests along number scales with psychometric markers ranging from “not at all” to “extremely”. The values indicate positivity/negativity (valence), and the general degree of arousal following the presentation of emotionally-laden stimuli. For valence, the mental operations underlying its delineation include dynamics of approach and avoidance types of behavior, not limited to a hedonistic pleasure-seeking component influencing motivation (Bradley & Lang, 2007). Characterizing arousal remains a more elusive, ambiguous endeavor. Sometimes frustratingly, arousal is subject to (co-occurring) influences stemming from psychological (e.g., perceived level of arousal) and physiological (response to bodily change) factors (Scherer, 2005), such as the multidimensional intertwinement of higher-order cognitive, motivational, and emotional influences (Handler & Honts, 2007). For example, Handler, Royner, and Nelson (2008) identified allostatic (roughly, the tendency to restore homeostatic functioning) physiological regulatory processes as a mechanism driving arousal in an effort to temper emotional reactions to salient stimuli during polygraph testing. Using the circumplex model as a theoretical foundation, briefly mentioning brain areas associated with the processing of its constituent dimensions offers informative clarification for its (more comprehensive) outline.

Work in the context of memory retrieval localized valence-related activation in the left frontal gyrus and thalamus (Altenmuller et al., 2014). Schneider et al. (1995), using positron emission tomographic (PET) methods, discovered activation in the amygdalae in response to negative valence, specifically. Inducing emotional states using words, Posner et al. (2009) found evidence of two separable systems for processing valence and arousal. Changes in valence correlated with activation in the insula, medial temporal cortex, several prefrontal cortical areas, and the amygdala; blood flow in the anterior cingulate and dorsolateral prefrontal cortex fluctuated alongside differential arousal ratings. Gerber and colleagues (2008) reiterated the notion of two distinct systems, finding blood flow changes associated with arousal in the amygdala, and an area in the medial prefrontal cortex; differences in valence correlated with activity in the anterior cingulate, temporo-parietal areas, and the fusiform gyrus. Clinical evidence also indicates the involvement of the amygdalae in processing arousal, as damage to the region inhibited subjects’ ability to process arousal, independent of stimulus recognition (Bernston, et al. 2007). In an MRI study using IAPS stimuli, Nielen et al. (2009) observed activation in medial temporal, orbitofrontal, and lateral prefrontal areas in response to changes in valence, and medial temporal, hippocampal, and ventrolateral prefrontal activation tied to arousal.

The above listing of neural networks and physiological changes associated with valence and arousal above is not meant to be exhaustive. However, it adequately represents some of the more ‘recurring’ areas of activation seen in response to emotional information processing, and serves as a decent locational outline of how (mechanistically) the human emotional experience may disrupt other forms of cognition in later stages of processing.

Emotion Induction

After settling on a model for the parsing of emotion, taking a brief look at the way emotions have been experimentally induced (visualized either as a function of a departure from a “baseline” state, or a switch between disparate categorical emotions) is valuable. A great degree of sensitivity can accompany emotional experiences, with some claiming that (merely) the act of appraisal itself generates emotion (Moors, 2013), and others citing evidence of the effectiveness of statements to induce emotion (Velten, 1968; Smallwood & O'Connor, 2011). The discussion below focuses on the different types of stimuli typically employed in emotional testing paradigms, with particular interest devoted to the issue of static versus dynamic induction methods.

The investigation of emotional processing often uses pictures, such as the collection of standardized images that make up the IAPS (Lang, Bradley & Cuthbert, 2008). The IAPS sees continued use, as Radua and colleagues (2014) demonstrated that exemplars (of both positive and negative valence) elicit brain activation during fMRI. Winton, Clark and Edelmann (1995) also successfully induced emotions with pictorial depictions of facial expressions. Further, static facial expressions associate with emotional information processing, even when neutral stimuli 'mask' the content (Suslow et al., 2013). The relationship between facial expressions and emotion induction persisted when temporal limitations make conscious processing unlikely (Prochnow et al., 2013). It appears that the usage of pictures to instantiate emotion remains a valid technique, producing results in both behavioral and neuroscientific domains.

Dynamic stimuli also effectively induce emotion. Studying the effects of emotion on motivation, Loizou, Karageorghis and Bishop (2014) manipulated emotional space (in terms of the circumplex model) using music and video clips. In the context of addiction research on self-control, Shmueli and Prochaska (2012) elicited emotion through positive and neutral videos and writing tasks. Similarly, Lazar and Pearlman-Avnion (2014) demonstrated successful mood induction using separate techniques (video and music clips); notably, with a stronger effect connected to the former. Demaree and colleagues (2004) found positive and negative videos (e.g., animal slaughterhouse footage) effective for emotion induction, observing physiological changes as well (variations in heart rate and skin conductance). Forgeard (2011) used positive, negative, and neutral videos to study the nature of emotional states and their impact on creativity. Indeed, the use of dynamic stimuli seems reliable for the induction of emotion, with both real actors (Winton et al., 1995), and computer-generated 3-dimensional faces (Vrticka et al., 2014).

While several methods experimentally induce emotional states, dynamic stimuli appear more suitable for the task; intuitively, they seem (by nature) more 'interactive' than their static (picture) counterparts. The act of 'keeping up with' an unfolding series of events in real time may also recruit additional mental resources, thus subjecting one to a higher likelihood of interference with cognitive processing at later stages.

Relevance to the Integrated Model

The above section focused on establishing a genesis point for the larger model of how emotion may impact deceptive behavior. I presented a theoretical account of emotion, evaluated both in terms of cognitive dimensions and neural processing mechanisms. An aim of the current project is to show that similar networks (and processes) are also involved at subsequent phases of the proposed model; and, that an overlapping systems view may offer partial explanation of how emotional experiences can interact with attention, decision making, and the ability to deceive. The present work also addressed contemporary competing models; revisiting them could be informative in terms of identifying limitations (or potential areas of expansion) in the discussion of emotional interference. Finally, a brief review of the types of stimuli used to induce emotion assisted in materializing the nature of events occurring at the initial stage of the dynamic model.

II. Emotion, Attention, and Decision Making

Applying a fixed quantitative structure to the science of decision making presents difficulty, particularly in arenas where ethical considerations are at play (Bates, 1954). In the context of a model involving an output of deception, approaching an interactive perspective with emotion requires a brief mention of aspects associated with decision making.

Recent work suggests that individuals likely adopt a consistent, singular strategy for problem solving, rather than selecting between multiple methods (Sollner, Broder, Glockner &

Betsch, 2014), though this notion is not without criticism (Elqayam & Evans, 2011). One component of decision making particularly applicable when suppressing the truth is the inhibition of a more powerful (prepotent) competing response. White et al. (2014), for example, found evidence of inhibition linked with brain activity in the right medial frontal and inferior gyri. Interestingly, Elwyn and Miron-Shatz (2010) proposed the inclusion of multiple emotional factors during the evaluation stage of decision making. In line with the current model, successful decision making is perhaps best viewed (in terms of deceptive output) along the dimensions of accuracy and efficiency (Dambacher & Hubner, 2015).

Cognitive Elements of Attention

A broad discussion of attention's intricate thematic constituents is not the intention of this review. Instead, this section illuminates two mental phenomena implicated in attentive processing (and the overall model under investigation): the central executive, and task rules. Originally conceived in the context of research on working memory (Baddeley & Hitch, 1974), the central executive (conceptually) underwent a progressive transformation. An idea of expansion replaced the notion of its exclusivity in terms of a restricted area within the frontal lobes (and 'singular' application to memory). Proponents now believe its reach (both anatomically, and with regard to process involvement) more widespread than initially thought (Baddeley, 1998; Garavan, Ross, Li & Stein, 2000).

A partial list of functions of the central executive includes: inhibiting information not relevant to goal-directed behavior, attention switching, integrating new with existing information, and the management of concurrent tasks (Collette & Van der Linden, 2002). Fournier-Vicente, Larigauderie and Gaonac'h (2008) offered similar justification for parsing the central executive to include the attentional aspects of selection and switching, though they failed to find compelling evidence of a (unique) dual-task management function. Conceivably, several executive processes from the abbreviated list above likely engage (if differentially) during the construction of a deception.

Another important cognitive concept relevant to the current project concerns task rules. Essentially, task rules are strategies (often categorically-based) thought to affect performance during cognitive testing. Some suggested that task-related information must be held in an 'active' representative form (Waskom et al. 2014). However, additional evidence indicated the implementation of task rules sometimes occurs through automatic processing, outside of the need for active maintenance (Yamaguchi & Proctor, 2011). There is also evidence that the manner in which task rules impact performance correlates in part with task complexity (Duncan, Schramm, Thompson & Dumontheil, 2012). Further, it is unclear whether the assignment of task rules facilitates performance or causes decrements, particularly in situations involving attention switching (Dreisbach, 2012). Notably, switching paradigms acquired longstanding use in the investigation of deception, though the presence of reliable effects has been debated (Debey, Liefooghe, De Houwer & Verschuere, 2014).

Neural Networks of Attention

The study of attention's subcomponents yields several loci of activation throughout the brain. Here, a thorough review is omitted in favor of a closer look at neural networks relevant to the current model. One of the more prominent circuits identified with attentional processing involves areas in the frontal and parietal lobes. The number of potential subdivisions within the fronto-parietal network continually evolves. Some researchers currently claim as many as eight constituents (separable by processing characteristics), such as the allowance for multiple representations that assists in task-switching (Szczepanski et al., 2013). Evidence from resting-state fMRI work reinforces the existence of a fronto-parietal network, citing the presence of an 'intrinsic connectivity network' (ICN), which demonstrated temporally synchronous activity between frontal and parietal areas, even in the absence of task demands (Markett et al., 2014). Further, Sripada et al. (2014) used fMRI to uncover fronto-parietal connectivity alterations in response to the emotional regulation strategy of reappraisal; Okon-Singer et al. (2014) provided supporting evidence of attentive processing (in response to negative and neutral emotional stimuli) linked with changes in fronto-parietal areas. Hilti et al. (2013) observed bilateral activation in a circuit involving fronto-parietal areas (and locations in cingulate and insular cortex) in response to attentional demands associated with a rapid visual information processing (RVIP) paradigm.

Additional research implicates specific frontal areas in attentional processing. Sridharan, Levitin, and Menon (2008), for example, found evidence of a right hemisphere fronto-insular connection when tasking subjects with switching between central executive and default mode (roughly, resting state) networks. Also, lateral prefrontal areas show activation in conjunction with attentive and evaluative processing, under conditions involving a variation of the oddball paradigm (Han & Marois, 2014). Further, both medial and lateral prefrontal areas appear to be involved when subjects are tasked with directing attention toward emotionally-laden pictorial stimuli (Ziaei, Peira, & Persson, 2014). Interestingly, evidence from clinical fMRI research points toward aberrant activity in the left dorsolateral prefrontal cortex during attention-guided tasks in adult ADHD patients (Hoekzema et al., 2014).

Considerable support exists for the notion of interactivity between neural systems underlying attentional processes. In a paper reviewing the neuroimaging of attention, Vossel, Geng, and Fink (2014) mentioned compelling examples of an interactive relationship between dorsal (frontal eye fields and the intraparietal sulcus) and ventral (temporoparietal junction and ventral areas of frontal cortex) circuits; the two networks presumably work in concert for the integration of top-down and bottom-up attentional processing. Similarly, Posner (2012) offered that while the networks (in this case referenced with functional designations "orienting" and "self-regulatory") may be anatomically distinct, their interaction could hinge upon task difficulty and/or switching. The ventral attentional network also links with subcortical structures such as the locus coeruleus (Walz et al., 2013), which connects to the amygdala (van Marle, Hermans, Qin, & Fernandez, 2010).

Attentional processing clearly occurs in several different cortical (and subcortical) locations. Fronto-parietal circuits subserving executive functioning (Collette & Van der Linden, 2002) are well-known. Translational research implicated an amygdalar-basal forebrain link in the processing of goal-oriented attention (Peck & Salzman, 2014), and attending to novel stimuli evoked activation of reward circuitry (Gottlieb, Oudeyer, Lopes, & Baranes, 2013). The areas discussed above demonstrate the extensive nature of the distribution of neural networks underpinning attentional processing.

Emotion and Attention

Taking a look at the dynamic relationship between emotion and attention helps build a case for the current model. Emotion and attention are strongly linked. Carretie (2014), in reviewing literature on exogenous attention, notes the efficacy of emotionally-laden stimuli in the elicitation of automatic attentional processing; Shaw et al. (2011) provided further evidence of emotion perception occurring outside of 'central' attentional processing in a study using facial expressions. Emotion also influences attentional scope. Huntsinger (2013) speculated that the induction of emotion affects whether individuals adopt a broad (global) or relatively narrower (local) attentional focus; though, the determination may lie more heavily upon one having access to either style. Specifically, the flexible link between emotion and attention seems to depend on the availability of global versus local focus. Interestingly, under certain conditions a positively-valenced emotional state sufficiently induced the use of both global and local focus (separately); negatively-valenced states produced similar results.

Whether the cognitive impact of emotional experiences facilitates or inhibits attentional processing remains unclear. In a recent review, Pourtois, Schettino, and Vuilleumier (2013) discussed evidence suggesting emotional induction increases performance, observable across behavioral measures of reaction time, and accuracy in spatial orientation tasks. Further, Sussman, Heller, Miller, and Mohanty (2013) offered the idea that performance-enhancing effects of emotional induction depend upon subtle changes in valence and arousal, finding improved task-related attention in response to low-arousal negative stimuli. Emotion induction also coincides with disruptive effects on attentional processing. In a study using IAPS stimuli, Sommer et al. (2008) reported decrements in task performance in a spatial cueing experiment following the induction of negative emotion. Additionally, Vogt and De Houwer (2014) noted the tendency for emotional suppression to impact attentive performance in a perseverative manner (using the emotion of disgust). Successful shifting of attention (from aversive stimuli) occurred in response only to the presentation of positively-valenced stimuli; neutral stimuli appeared ineffective in this regard.

The interactivity between emotion and attention is also discernible in neural terms. Pourtois, Schettino, and Vuillemier (2013) documented both direct and indirect (such as through the basal forebrain) amygdalar projections to frontal, parietal, and various areas of sensory cortex. Concerning the diminished fear response associated with psychopathy, Larson et al. (2013) have also implicated a connection between goal-directed attention and emotion in both amygdalar and lateral prefrontal areas, though additional work illustrates the capacity of more medial prefrontal areas to resist emotional interference (Geday & Gjedde, 2009). Reviewing the temporal nature of emotion-attention interactions, Pessoa (2010) also deemed the amygdala an instrumental site.

Growing evidence indicates the importance of the thalamus in mediating the relationship between attention and emotion. In a review of neuropsychological literature, Arend, Henik, and Okon-Singer (2014) noted specific subdivisions of the thalamus (particularly pulvinar areas) show involvement with binding emotional content in working memory processes. Further, Hartikainen et al. (2014) found the therapeutic technique of deep brain stimulation, when applied to thalamic areas, affected both response inhibition and attention allocation to threatening stimuli (rearranged elemental figures in a go-no go task). Thalamic-cortical connections are also implicated with complex appraisal functions during evaluative emotional processing (Handler, Deitchman, Kuczek, Hoffman, & Nelson, 2013). The brief review above establishes numerous cognitive domains and neural locations as fitting candidates for the interplay between attention and emotional processing.

Emotion and Decision Making

In order to assist with theoretically validating the model under investigation, we must examine the relationship between decision making and emotional processing. Threat detection is considered a simplistic form of decision making. Accordingly, LoBue (2014) found evidence that negatively-valenced emotion induction facilitated the rapidity of detecting threatening stimuli. In contrast, studies involving clinical populations indicate the disruptive effects of negative emotional states on decision making in those with anxiety and depression (Paulus et al., 2012). Positive valence also demonstrably impacted decision making, though it may be less effective than its negative counterpart (Mohanty & Suar, 2014). Investigators debate whether positive and negative emotions exert consistent, directional effects on decision making, however, with some favoring an approach that evaluates the influence of valence at the level of unique emotions (Lerner & Keltner, 2000; Jeon, Walker, & Yim, 2014).

That changes in arousal can produce differential effects on performance is a long-held idea (Yerkes & Dodson, 1908). More recently, in a review of factors that influence decision making, Roets and Van Hiel (2011) ensconce arousal firmly in an integrated model of precursors to judgment and decision processing, placing the emotional dimension early in the chain of processing. Further, Suri, Sheppes, and Gross (2013) identified the component of arousal in a model developed to predict decision making outcomes. Moriya, Takeichi, and Nittono (2013) assert that variations in arousal emerge during lexical decision tasks, and may facilitate semantic representation. It seems realistic to acknowledge that fluctuations in arousal levels likely impact many cognitive processes (including decision making). It remains unsettled the extent to which individual differences in factors such as personality may influence the effects of arousal manipulation on later processing (Dresler, Meriau, Heekeren, & van der Meer, 2009).

Supporting evidence exists that the interaction between emotional processing and decision making may also take place indirectly, involving additional constructs beyond valence and arousal (Phelps, Lempert, & Sokol-Hessner, 2014). In a series of experiments looking at 'intuitive' decision making (in the form of an updated version of the Iowa gambling task), Dunn et al. (2010) found that altering the level of interoception (perception of bodily change) affected both decision making and the perception of emotion. Fallon et al. (2014) observed increased information searching ability in subjects with higher emotional intelligence. Further, the act of reappraisal influenced the acceptance of hypothetical 'offers' in economically-based decision scenarios (Grecucci et al., 2013). Taken together, the work above illustrates the widespread potential for a dynamic relationship between emotional processing and decision making.

Emotion and Cognitive Load

Emotional processing also exerts putative effects on cognitive load. Miller (1956) long ago put forth the notion of limited resources to devote to mental operations involving information processing. Further, when taxed by tasks which divide attention, the allocation of those resources can widen or narrow one's field of view (Williams, 1982). Cognitive load, then, is imaginable as the relative amount of strain on processing resources at a given point in time. Sweller (1988) framed the matter in terms of learning, where the acquisition of more 'expert' based schemas allows for greater efficiency in cognitive processing; others favored a more 'direct' approach believed to better disentangle individual mechanisms (van Gog et al., 2009).

Choi, van Merrienboer, and Paas (2014) recently emphasized the importance of emotional characteristics of the learning environment in attempting to name contributing influences on cognitive load. Consistent with the concept of limited resources, Berggren, Richards, Taylor, and Derakshan (2013) observed a decreased impact of emotion induction (using facial expression stimuli) on attentional processing under conditions of elevated cognitive load. Pessoa (2010) hypothesized emotion-attentional networks' involvement with certain selective processes, assisting in the selection of attention to environmental stimuli. Despite pronounced variability in the available processing capacity unique to an individual's cognitive load (Fitousi & Wenger, 2011), the study of the nature of mental resource allocation remains promising (Lavie, 2010). Cognitive load also likely serves a mechanistic interaction between emotion and attention. Emotional experiences demonstrate influences on attentional processing (Li et al., 2014), and it is possible this phenomenon reflects a 'preference' (in terms of resource allotment) given to the processing of salient information. Simply, when heavily-emotional information taxes one's cognitive capacity, a reduced ability to perform additional mental operations may result.

Arousal and Attractiveness

The ability to successfully construct a deception is instrumental to the current model. In the present paradigm, deceptive responses refer to the perceived attractiveness ratings of others. The arousal dimension of the circumplex model may influence such judgments. Dutton and Aron's (1974) landmark study addressed the question with participants walking across either of two levels of a suspension bridge. They found subsequent attractiveness ratings of an 'interviewer' (confederate) were inflated when participants traversed the higher level (indicative of relatively greater arousal). Dienstbier (1979) observed a similar phenomenon when manipulating arousal through a startle-response. In the series of studies, when sudden loud noises accompanied rapid vestibular deflections (induced by tilting chairs), attractiveness ratings of the experimenters increased. The nature of the link between physiological arousal and attractiveness is still under investigation, with more recent work focused on attributes such as arousal source ambiguity (Foster, Witcher, Campbell, & Green, 1998) and power over others (Jouffre, 2015).

Relevance to the Integrated Model

The preceding section represented the next (multifaceted) stage of processing in the larger model, accomplished by following the path from emotion induction to the potential 'next stage' targets: attention (generally), decision making, and cognitive load. Cognitive-theoretical and neural network depictions of attentive processing elucidated numerous avenues for emotion-attention interaction, including the idea that emotional processing may be a significant determinant in the allocation of attentional resources (framed as cognitive load). I presented research highlighting the differential effects of fluctuations in the circumplex model on decision making ability, offering a more broad review of relevant work with circumplex dimensions, and (through the specificity of the current paradigm) by linking changes in arousal with ratings of attractiveness. Taken together, the relationships discussed above provide compelling evidence of emotional induction's involvement with attentive and decision making processes. Moreover, the structure of the current model carries the likelihood that the interplay detailed influences the output of deceptive behavior.

III. Emotion, Cognitive Load, and Deception

The previous sections identified links between emotional processing, general aspects of attention, cognitive load, and decision making (Schulz, Fishbacher, Thoni, & Utikal, 2014). Deceptive behavior serves as an endpoint in the current putative model. The focus below relies on the acquisition of a greater awareness of more precise mechanisms at play during the final phase of information processing in the model. The concept of cognitive load (and the concomitant notion of resource-restricted processing capacity) then becomes a running backdrop for considering the following associated phenomena: emotion regulation, inhibition, emotional perseveration, and task switching. Each 'operation' presumably acts an impediment to deception construction.

Emotional Regulation

If any mental operation potentially affects the strain on cognitive load, then it is worthwhile to imagine acts of processing associated with the maintenance (or reversal) of one's emotional state in such a manner. Thought suppression is one of the more frequently employed strategies in the regulation of emotion. While seemingly adaptive (in terms of shielding against negatively-valenced experiences), the act of suppression often carries a cost (Geiger, Peters, & Baer, 2014). In a series of experiments, Baird et al. (2013) directed subjects to suppress intrusive thoughts about previous romantic relationships. They found suppressed thoughts linked with a "decoupling" of attention from task performance, and that emotional content affected cognitive load outside of conscious awareness. Apart from one's romantic history, Nixon, Nehmy, and Seymour (2007) noted more immediate effects of cognitive load linked with the presence of intrusive thoughts. Further, Najmi and Wegner (2009) observed thought suppression associated with a 'rebound' of the intended target(s) to be suppressed, and highly taxing on cognitive load; the researchers also questioned its overall effectiveness for emotional control. Thought suppression clearly involves cognitive resources. Applying an emotional component to that dynamic may add another impediment to the increasingly difficult task of deceptive behavior.

Inhibition

In order to lie successfully, one must often suppress the (reactive) truthful response (Verschuere, Spruyt, Meijer, & Otgaar, 2011; Hadar, Makris, & Yarrow, 2012); such an act likely incurs a measureable cognitive penalty. Simply, the inhibition of a truthful response (as a precursor to deceptive behavior) should manifest in longer reaction times when lying (compared to truth-telling). In support of this idea Farrow et al. (2010) reported a temporal disadvantage to lying in terms of processing speed, and suggested that individual variability in verbal memory may enhance the difference. The discrepancy between lying and truth-telling (through the behavioral lens of reaction time) appears generally reliable, but the temporal gap contracts under certain circumstances. Hu, Chen, and Fu (2012), for example, implemented a paradigm involving lying about self-referential information. They found that subjects who received instruction to reduce speed displayed significantly lower reaction times when lying, and that the processing difference between lying and truth-telling essentially disappeared under a condition of more intensive training. Additionally, in a study manipulating the ratio of lying to truth-telling across conditions, Van Bockstaele et al. (2012) observed a decrease in reaction time to deception construction in response to specific training. It appears that, while malleable, a cognitive cost of lying does indeed exist; though, practice effects ought to be taken into consideration when developing experimental paradigms.

Emotional Perseveration

The perseveration of emotional states potentially obscures one's ability to manufacture a deceptive response. Using IAPS stimuli, Smith, Bradley, and Lang (2005) showed behavioral indicators (such as startle potentiation and frowning) persistently evident for prolonged periods of time (~30s) following exposure to negatively-valenced items; though, some supporting evidence hinted that the measurement scale may affect the perception of emotional duration (Verduyn, Tuerlinckx, & Van Gorp, 2013). Attentional processing possibly influences the duration of an emotional experience. Freund and Keil (2012) noted that a redirection of attention from emotionally-laden content sufficiently and effectively 'compressed' the length of subjects' emotional experiences. Verduyn and colleagues (2009) contended that emotional duration rests upon characteristics of strength of emotion at onset, and stimulus salience. Further, Waugh, Lemus, and Gotlib (2001) speculated that both 'active' and 'passive' processes influence the perseveration of emotion, in accordance with explicit awareness. Emotional perseveration also associates heavily with errors in decision making (Hauser, 1999); a dynamic which could interfere with accuracy during tasks requiring both lying and truth-telling. Clinical evidence implies that a dimension of perseveration in anxiety could impact susceptibility to negative emotional states (Rudaizky & MacLeod, 2014). Given the length of emotional experiences coupled with the multipronged accompanying set of putative influential factors, prolonged states of emotion could easily disrupt the construction of a deception.

Task Switching

Many paradigms testing deceptive ability obligate subjects to switch between truth-telling and lying across trials. Diverting resources from one mental task to another in such a situation feasibly contributes to cognitive load. That act of 'rerouting' produces an experimentally-verified processing cost, as Schmitz and Voss (2014) noted increased reaction times under conditions of switching on a letter-number task. Research also suggests that the cognitive cost of task switching stems from the inhibition of (previously activated) processing pathways (Scheil & Kleinsorge, 2014). The impact of emotional involvement on task switching is less well-understood. Yang and Yang (2014), for example, observed decreased reaction times in a card-sort task in a condition of positively-valenced emotion, relative to a neutral state. However, in a sentence-rating task manipulating focus (internal vs external), Oosterwijk et al. (2012) detected similar processing costs across emotional and non-emotional states. In the context of deception, switching between lying and truth-telling also affects processing speed. Debey, Liefooghe, De Houwer, and Verschuere (2014) reported bidirectional (lie-to-truth, truth-to-lie) decrements in reaction time when participants were tasked with switching. Further, Christ et al. (2009) demonstrated activation in frontal, insular, and left posterior parietal areas linked with task switching in a deception paradigm; notably, regions associated with task switching significantly overlapped with areas involved in other executive processes (such as working memory and inhibitory control).

Relevance to the Integrated Model

Research highlighted in the section above represents an effort to account for some of the more pronounced cognitive influences on the ability to deceive. Specifically, the review offered a parsed description of contributing factors at the later stages of processing (believed to more immediately precede the output of deception). Thought suppression as a function of emotional regulation likely taxes cognitive resources that could slow reaction time in a deception-based paradigm. More specifically, the necessary inhibition of truthful information (tied to a given deception) seems to effectively inflate costs associated with processing speed. The perseveration of emotional states warrants additional consideration, as the experimental design of the current model builds (at least in part) on an assumption of one's ability to repeatedly (and relatively expediently) transition between disparate emotional states. Finally, I addressed the idea that task switching influences cognitive load; whether emotional processing facilitates or inhibits remains less clear at this stage. Reference to additional work outlined potential costs in the context of switching between lying and truth-telling.

IV. The Overall Path from Emotion Induction to Deception

This paper moves toward an answer to a (seemingly) basic question: does emotion influence the outcome of deceptive behavior? In light of the work detailed above, this appears a gross oversimplification of the matter under investigation. An initial approach to the question, then, required considerable exploration of the current model's starting point: emotion. I discussed the issue of automatic versus controlled processing, reaching a suitable operationalization for emotional content in the form of the circumplex model. Widespread neural networks underlying emotional processing were presented (Ziaei, Peira, & Persson, 2014), accompanied by a brief review of some of the more common types of stimuli (pictures, video, music clips) used to induce emotional states.

A review of the putative influence of emotion on processing in attention (generally), cognitive load (specifically), and decision making marked the next phase of the model. Cognitive and neuroscientific evidence established a firm relationship between emotion and attention. Indeed, speculation abounds that emotional and attentional processing frequently use similar networks, and that the two phenomena separate less-well than previously conceived (Pessoa, 2013). Additionally, I examined the impact of emotion on a system with limited processing capacity. Emotional characteristics affect many areas of executive functioning (Harle, Shenoy, & Paulus, 2013), and may also exert pressure indirectly through interaction with attentional mechanisms (Li et al., 2014). Decision making appears susceptible to manipulations of the dimensions of valence and arousal; though a more appropriate consideration of influence at the level of specific emotions remains plausible (Lerner & Keltner, 2000).

The final stage represented in the current model covered two separate (but linked) sets of relationships. First, I detailed a group of specific cognitive operations in an attempt to illuminate some of the more immediate ways in which deception construction alters due to processing demands. Deceptive ability may be disrupted (or in some cases, potentially enhanced) by processing involved with the duration (and regulation) of emotions, inhibiting truthful information prior to deception, and task switching in paradigms requiring lying and truth-telling. Second, the suspected dynamics between the precursors outlined in preceding sections bears mention. In a recent review, Gaspar and Schweitzer (2013) asserted that complex decision making situations demonstrate vulnerability to the impact of emotional processing, and that observable changes in emotion both before and after the act of deception emerge. Further, Walczyk et al. (2014) reiterated the notion that emotional states can strain cognitive load when one attempts to deceive. Dunbar et al. (2014) also postulated that successful deception necessitates the management of attentional resources in monitoring thoughts and actions of (both) the deceiver and the target of deceiver. Decrements in the ability to deceive (presumed as consequence of cognitive resource strain) also accompanied a reduction in speech rate (Gamer & Ambach, 2014), perhaps best envisioned analogous to a reaction time measure.

The primary goal of this paper was to trace a path from emotion induction to deception construction; operating from a 'levels of analysis' perspective facilitated the accomplishment of this task. I addressed key elements both individually, and in the context of the nature of their interactions on a more global scale within the overall model. An obvious limitation of the current discourse manifests when examining the directionality of relationships between constructs discussed above. Frankly, the outline followed the progression from emotion induction to the act of deception in a solely unidirectional manner. Putatively, the relationships between cognitive load, attention, and decision making (as precursors of deception) exhibit more recursive tendencies. However, a full examination of the nuances of those relationships outstretched scope of this paper. Instead, I focused on the establishment of a foundational framework to represent a 'stream' of influence from emotion to deception, reserving a more detailed exploration of potential bidirectional relationships among contributing factors for future iterations.

Future Directions

Much of the literature on deception directs inquiry to changes (behavioral and physiological) elicited during the act of lying. However, deceiving covers only part of the equation; an intended target must also play a role. Considerably less research looks at factors which may influence one's susceptibility to deceptive communication. Harrison, Hwalek, Raney and Fritz (1978), studying cues to deception revealed through interviews, found increased hesitation and (generally) longer responses associated with low believability. These findings reconcile with the work discussed above in the context of cognitive cost. Interestingly, Levine et al. (2011) noted that manipulating a communicator's demeanor (honest vs. dishonest) significantly impaired the ability to detect deception. Further, the confidence portrayed by witnesses (during testimony) appears directly related to subsequent judgments of believability (Tetterton & Warren, 2005). Also, research suggests that self-awareness may increase one's ability to deceive through an enhancement of being able to gauge the mental states of others (Johnson et al., 2005).

Investigating qualities in 'target' individuals that could promote vulnerability, in conjunction with examining the characteristics affecting the veracity of someone committing an act of deception, offers potential utility. James, Boyle, and Bennett (2014) observed an increased susceptibility to financial scams as a function of age, and indirect relationships between susceptibility and a set of socioeconomic factors (income, social support, etc.). Emotional induction may facilitate the detection of deception, as LaTour and LaTour (2009) found participants in positive moods generally less susceptible to false advertising scenarios. Incorporating similar methodology into the framework underlying the current model could prove interesting.

The present global landscape represents fertile ground for studying the impact of deceptive behavior. If emotional induction reliably produces demonstrable effects on the susceptibility to deceptive communication, then far-reaching implications emerge. In political speeches, for example, audience members may eventually acquire skills to avoid distraction through emotional appeals and instead maintain a focus on message content. Concerning national security, interrogators could gain additional awareness of how their own emotional state(s) impact the effectiveness of their questioning techniques. In family situations, cues to risky adolescent behavior might be more detectable if parents learn the nature of emotional involvement in deception susceptibility. Plainly, the identification of a relationship between emotion, deceptive ability, and vulnerability to deception potentially serves to inform virtually any context involving social interaction.

Conclusion

That emotion impacts many forms of cognitive processing does not seem disputable. It remains less obvious whether the influence of inducing disparate emotional states contributes to cognition (consistently) in an enhancing or detrimental fashion. Attentional resources and decision making efforts routinely underlie acts of deception. Further, the group of elements outlined in the model above carries a substantial degree of complexity. Accordingly, such an avowal places deceptive behavior under the impact of a multi-tiered system of (potentially) competing factors. Additional research should focus on investigating the dynamics between emotion, attention, decision making, and cognitive load. A more refined look at the nature of interaction between constituents in the current model offers the chance for a greater understanding of precisely how an act of deception manifests.

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