fMRI Reveals Differences in Attention Associated with Developmental Conversations

by

Angela Passarelli[a*]
Richard E. Boyatzis, [b]
Abigail J. Dawson[d]
Anthony I. Jack[c]

[a]Department of Management & Marketing
College of Charleston
55 George Street
Charleston, SC 29424

[b]Department of Organizational Behavior
[c]Department of Cognitive Science
Case Western Reserve University
10900 Euclid Avenue
Cleveland, OH 44106

[d]Legendary Entertainment
Applied Analytics
535 Boylston St, Suite 401
Boston, MA 02116

*Corresponding author: Tel: 724.712.9182; E-mail: passarelliam@cofc.edu

WP-16-03

fMRI Reveals Differences in Attention Associated with Developmental Conversations

by

Angela Passarelli[a]*
Richard E. Boyatzis, [b]
Abigail J. Dawson[d]
Anthony I. Jack[c]

[a]Department of Management & Marketing
College of Charleston
55 George Street
Charleston, SC 29424

[b]Department of Organizational Behavior
[c]Department of Cognitive Science
Case Western Reserve University
10900 Euclid Avenue
Cleveland, OH 44106

[d]Legendary Entertainment
Applied Analytics
535 Boylston St, Suite 401
Boston, MA 02116

*Corresponding author: Tel: 724.712.9182; E-mail: passarelliam@cofc.edu

This research was possible with funding from the H.R. Horvitz Chair held by Professor Boyatzis.

Abstract

This paper addresses key theoretical and methodological challenges that have been raised regarding the use of neuroscience in organizational research. In doing so, we present the results of an fMRI study that integrated theories of attention and intentional change in proposing that coaching interactions focused on the Positive Emotional Attractor state (PEA) would be associated with big picture thinking and, thus, global attention. On the other hand, coaching interactions focused on the Negative Emotional Attractor state (NEA) would be associated with attention to local details. Using neuroimaging to examine conjunctive cortical activation between PEA/NEA coaching and global/local visual attention, we found robust support for hypotheses related to this proposition. A pattern of overlapping neural activation was found linking PEA- and NEA-based coaching to global and local attention, respectively. PEA coaching and global processing produced activations that were lateralized to the right hemisphere and located in the visual associative cortex (e.g. right precuneus and middle temporal gyrus). Neural activity associated with NEA coaching and local processing was left lateralized and located in the early visual areas (e.g. left inferior occipital gyrus). This overlap suggests attentional processing is a highly relevant factor in determining how individuals respond to different kinds of coaching.

Introduction

It is difficult to contemplate how management can be done without the use of one's neurons. Hence, while other papers in this special issue and other management journals over the last several years have questioned the utility of organizational neuroscience research, we believe when conducted with the methodological rigor of a sound experiment and logic of good science, studies that shed light on the neural mechanisms of key organizational processes can and should represent one valuable aspect of organizational research. In order to make such a contribution without falling into the trap of naïve reductionism (Lindebaum & Zundel, 2013), we present a study that uses a methodological approach specifically designed to overcome one of the key inferential problems in neuroscience, namely the problem of attributing overly specific functions to brain regions – known colloquially as a 'phrenological' approach to brain mapping.

This paper has two objectives. First, it presents an empirical study of the shared neural correlates between two approaches to coaching and two forms of attention. Second, it illustrates a number of ways neuroimaging can be useful to management theory and research by responding to key issues raised in critiques of organizational neuroscience. The second objective is addressed briefly here and expanded upon in the Discussion section.

Addressing Problems of Functional Specificity and Reverse Inference

A major problem with neuroscience is the phrenological approach encouraged by standard localization of function designs. These designs, which attempt to localize brain regions involved in a particular psychological process, tend to promulgate a view that overly specific constructs are associated with particular brain regions. However, from a broader perspective, it is clear that this does not characterize well how the brain is actually organized. While there is demonstrable functional specialization of the brain, it is broader than the types of psychological constructs that are often used. In terms of those types of psychological constructs, it is clear that virtually all brain regions do many things, and often things which appear at first quite distinct. A key symptom of this mismatch between how many neuroscience experiments have been done and how the brain is actually organized is the methodological problem of reverse inference - the assumption that activation in a brain region can be attributed to the operation of a specific psychological function (Poldrack, 2011).

Here we take a quite different approach. We use cognitive conjunction to identify some fundamental but domain-general processing differences (e.g. two different types of attention processing). We examine these two types of attention in two very different domains – coaching and visual processing. In our prior work we have argued that a key theoretical distinction can be made between different approaches to coaching in terms of what kind of information people are asked to focus on in the coaching interaction (Jack et al., 2013; Boyatzis, 2008). Our proposition is that these two approaches to coaching relate to two well-studied styles of visual attention - namely global versus local processing.

Two Approaches to Coaching

Coaching has become an increasingly common strategy for developing talent in organizations (Bono, Purvanova, Towler, & Peterson, 2009; Segers, Vloeberghs, Hendrickx, & Inceoglu, 2011). Generally occurring in a dyadic relationship between an employee and a professional coach or manager, coaching is a customized intervention aimed at developing an individual's career or work-related capabilities (Kauffman & Coutu, 2009; Peterson, 1996). The coach's role in such interventions is to help the coachee persist in his or her developmental efforts to become more effective. This requires helping him or her to be open to new possibilities, learning and change.

Two primary approaches to coaching interactions have been identified (Boyatzis, Smith, & Blaize, 2006; Sue-Chan, Wood, & Latham, 2012). One approach deals with proximal performance concerns and, hence, emphasizes external standards, performance deficits, and potential derailers in considering future action for development. The other approach contextualizes development in an ideal image of the future, emphasizing the individual's aspirations, values, and core identity. The latter approach is less common, but arguably more effective for pursuit of complex goals because of its link to promotion-oriented self-regulation (Sue-Chan, Wood, & Latham, 2012; Zhang, Cornwell, & Higgins, 2014) and positive emotional states (Fredrickson & Branigan, 2005).

Based in Intentional change theory (ICT; Boyatzis, 2008), these two approaches to coaching invoke distinct states called emotional attractors (Boyatzis, Rochford & Taylor, 2015; Howard, 2006). Each emotional attractor has neurobiological correlates that both affect and are affected by psychological processes. One such process is how individuals attend to and process information. In particular, we contend that the coaching approach impacts what a coachee sees in his or her mind's eye via social influences that activate global or local attention (Boyatzis et al., 2015; Förster, 2012). These attentional frames are consequential for coaching because they affect what and how information is perceived, processed, and acted upon by coachees (Sue-Chan et al., 2012). This subsequently impacts how they construe and pursue developmental goals (Lord & Hall, 2005) and enables or hinders their progress toward desired change (Boyatzis, 2008). Using functional magnetic resonance imaging (fMRI), this study confirms initial evidence that these approaches to coaching differentially recruit neural networks common to global and local visual attention (Jack et al., 2013).

Coaching for Intentional Development

A central goal of coaching is to assist individuals in creating enduring behavior change that results in greater effectiveness (Bono, Purvanova, Towler, & Peterson, 2009). According to ICT, this form of sustained development occurs through a complex process in which individuals adopt new behaviors to reduce the discrepancy between an ideal-future self and real-current self (Boyatzis, 2008; Higgins, 1987). This process is aided by relationships with supportive others, such as a coach, who assist in discovering one's ideal self, accurately assessing one's real self, and formulating an agenda for intentional action toward behavior change.

The ideal self, or personal vision, plays a critical role in intentional development, yet it is often neglected as part of a coaching process. The ideal self is a possible self that consists of one's aspirations for the future, core identity (values, social identity), and the emotional driver of hope (Boyatzis & Akrivou, 2006; Higgins, Roney, Crowe, & Hymes, 1994). Coaches assist others in discovering their ideal selves by utilizing questioning techniques designed to elicit an exciting, holistic image of a desired future (Boyatzis, Smith & Beveridge, 2012; Howard, 2015; Passarelli, 2015).

Coaches who engage coachees in visioning arouse in them the PEA which is a psycho-physiological state characterized by three dimensions: positive emotions, dominant arousal of the parasympathetic nervous system and related hormones, and predominant neural activity in the Default Mode Network (DMN). Being in this state, as predicted from research on the components, suggests that a person has increased working memory, cognitive openness, creativity, ability to handle complex tasks, openness to people and emotions, and optimal immune system functioning (Boyatzis et al., 2012; Boyatzis et al., 2015; Jack et al., 2013).

In contrast, the NEA state occurs when a person is defensive or under stress (Boyatzis, 2008). It is characterized by negative affect, having a dominant arousal of the sympathetic nervous system, and a predominance of neural activity in the Task Positive Network (TPN) (Boyatzis et al., 2012; Boyatzis et al., 2015; Jack et al., 2013). When chronically invoked, the person may be cognitively, perceptually and emotionally impaired. Because of a natural proclivity toward negative or threating information, the NEA is often invoked while discussing one's real self – a possible-self regarding one's capabilities informed by the assessment of both self and others (Taylor, 2006). The NEA state may also arise from a real or perceived need to comply with social expectations, pressures, and controls - one's "ought self" (Higgins et al., 1994) – and from aspects of a desired future one fears will not occur, or disturbing moments in relationships. Coaching that emphasizes the NEA may inhibit learning and change, or render initial efforts as not sustainable (Boyatzis et al., 2015). It may be counterproductive in situations that call for creativity, openness, and sustained motivation by limiting a person's field of perception.

Both PEA and NEA states contribute to development. However, ICT holds that the timing and sequence of these states are important. We have argued elsewhere for the advantages of invoking the PEA-state early in the coaching relationship (Boyatzis et al., 2006, Boyatzis et al., 2013; Passarelli, 2015), and balancing the ratio of PEA and NEA interactions (Howard, 2015). In other words, we suggest that the benefits of the PEA are best leveraged when a coach attempts to stimulate the PEA at the beginning of a coaching engagement and returns to it periodically through the process. This would imply that the coach attempts to direct the person's attention to the "big picture" or reason for and general desire to change. At other times, the coach would require the person to consider details in experimenting with and practicing the new behavior. The former calls for global attention and the latter for local attention.

Coaching to the P/NEA and Global/Local Attention

Global and local attention represents two approaches to processing information – a focus on the whole versus a focus on the component parts, respectively. These forms of attention are influenced by internal and external cues such as mood, self-regulatory focus, safety-threat, and distance (Förster & Dannenberg, 2010), suggesting that interactions with a coach could trigger which processing style is adopted. Whether global or local attention is triggered may affect how an individual deals with complex, ambiguous, and sometimes evaluative or threatening information in the coaching process. Global attention fosters creative, big picture thinking and integration of novel, uncertain, or incomplete data into inclusive, superordinate knowledge structures. Local attention, on the other hand, emphasizes differentiation, attention to detail, and activation of narrow cognitive categories that can lead to the omission of important incoming stimuli (Förster, 2012). Certainly these forms of attention will differentially impact sense-making processes. Additionally, there is evidence that attentional focus is associated with self-regulation (Förster & Higgins, 2005), and can carry over to subsequent unrelated tasks (Macrae & Lewis, 2002). Hence, attention plays an important role in key coaching processes. Although global-local attention is multi-modal in terms of sensory stimulation (Förster, 2012), we focus here on visual attention because it has a strong base in both the psychological and neuroscientific literatures.

Just as coaching conversations involve both PEA and NEA elements, processing visual information requires attention to both global and local components of the stimuli (Han, Weaver, Murray, Kang, Yund, & Woods, 2002). Under normal conditions, healthy individuals tend to demonstrate a bias for global attention, processing the global features of an image before the local details (Navon, 1977; Rauschenberger & Yantis, 2001). However, global and local attention are influenced by positive and negative emotions, respectively (Fredrickson & Branigan, 2005; Gasper & Clore, 2002). This phenomenon can be described from both a psychological and neurobiological perspective.

Psychological. It is widely asserted that negative emotions such as fear and anxiety narrow one's scope of attention and perceptual field of vision, such that individuals may miss seeing the big picture because they are focused on component parts. In contrast, positive emotions broaden one's scope of attention (for a review see Derryberry & Tucker, 1994). A number of interpretations have been provided for this. First, Gasper & Clore (2002) draw on the affect-as-information theory asserting that task-relevant emotions guide cognitive processing (i.e. emotions direct one's attention to either global or local features of a stimulus). Specifically, they contend that positive moods encourage reliance on information that is readily accessible – such as existing scripts – rather than processing new, detailed information. Negative moods, on the other hand, send the message that existing scripts are insufficient and therefore promote the use of incoming information, necessitating the processing of detailed local features. Two experiments in which positive and negative moods were induced provided evidence that "individuals in sad moods are less likely to see the forest and more likely to see the trees than individuals in happier moods" (Gasper & Clore, 2002, p. 39). However, their experimental procedures did not produce a control group that was sufficiently different from those in the positive mood condition, thus leaving the interpretation of the effect of positive emotions in question.

A second interpretation of the positive-global and negative-local association rests on Fredrickson's (1998) 'broaden and build' theory of positive emotion, which holds that positive emotions serve to broaden thought-action repertoires. Using this theoretical framing, Fredrickson & Branigan (2005) refuted the affect-as-information perspective. They found that both high- and low-activation emotional states – amusement and contentment, respectively – were associated with broadened scope of attention, and this was also associated with greater number of outcome ideas. Furthermore, global processing was stronger in positive as compared to neutral moods. Negative affect, however, did not result in narrowed attention – a result they ascribe to weakness of the stimuli used to induce negative emotion. Although we agree with the theoretical explanation of Fredrickson's work, the findings from both studies inform our hypotheses.

An additional group of studies finds the same relationships between affect and attention based on dispositional traits (Basso, Schefft, Ris, & Dember, 1996; Derryberry & Reed, 1998). Drawing on this body of work, we expect attention to vary with coaching such that PEA-based interactions are associated with global attention and NEA-based interactions are associated with local attention. Furthermore, we expect this relationship to be evident in patterns of neural activity as described in the following section.

H1. Coaching to the PEA will activate neural networks associated with global attention.

H2. Coaching to the NEA will activate neural networks associated with local attention.

Neurobiological. The neurobiological perspective asserts that psychological processes are rooted in our cognitive machinery. Not surprisingly then, visual attention and visual imagery have been the subject of neuroimaging research yielding broad agreement that global and local visual processing (1) are lateralized to different hemispheres of the brain (Fink et al., 1996; Martinez et al., 1997; Han et al., 2002; Weissman & Woldorff, 2004) and (2) differentially draw on visual associative areas and primary visual areas of the brain (Ganis et al., 2004; Han et al., 2002).

Hemispheric differences in processing global and local stimuli have been noted in studies of individuals with lesions in the right or left side of the brain. Specifically, individuals with lesions in the right temporal-parietal junction have impaired global processing and those with lesions in the same region on the left have difficulty processing local information (Lamb, Robertson, & Knight, 1989, 1990; Robertson, Lamb & Knight, 1988). This finding is consistent with research on healthy subjects. For example, Han et al., (2002) found that when compound letters (i.e. Navon figures) were presented centrally in the visual field, global attention produced greater activation in the right lateral occipital cortex whereas local attention produced greater activation in the left inferior occipital cortex, results which were consistent with those of Martinez et al. (1997) and Fink et al. (1996). These hemispheric asymmetries exist when distinguishing between global and local features of stimuli both in allocating attention for 'preparatory control' before the stimulus is presented and for 'feature identification' after stimuli is presented (Weissman et al., 2005). Low demands on attentional control seem to attenuate this pattern, whereas high demands have the opposite effect (Fink et al., 1996; Weissman et al., 2005). Because the task utilized in the current study presents compound letters centrally with relatively high attentional demands due to switching between global and local attention cues, we expect to observe hemispheric differences between the PEA-global and NEA-local processing.

H3. Coaching and visual attention will show hemispheric asymmetry such that neural activation for global attention (and PEA coaching) will be more extensive in the right hemisphere and local attention (and NEA coaching) will be more extensive in the left hemisphere.

In addition to hemispheric asymmetry in global and local attention processing, these two forms of processing visual information appear to recruit different areas in the sensory processing stream. Our hypotheses here are informed by an earlier study examining the neural correlates of PEA and NEA-based coaching interactions, which revealed that these two coaching approaches were distinguished by activation in visual associative areas (temporal cortex) and primary visual areas (occipital cortex), respectively (Jack et al., 2013). This finding was consistent with research on visual imagery. For example, Ganis, Thompson, and Kosslyn (2004) concluded that visual perception of an external stimulus and imagining that same stimulus recruit shared neural networks in the frontal and parietal regions, areas responsible for cognitive control. However, activation differed in the temporal (imagery) and occipital (perception) regions, suggesting a difference in basic sensory processes. It follows that we would expect to see similar differences in sensory processing to the extent the PEA coach encourages the participant to call to mind a desired present or future state and thereby engage in visual imagery. In addition, because perception of global stimuli – or the gestalt of an image – requires use of the imagination to fill in missing pieces, we expect global attention to share neural activation with PEA-coaching in visual associative areas such as the temporal cortex. In contrast, processing local information requires careful attention to details, suggesting it will recruit early visual areas as was demonstrated in the NEA-coaching condition in Jack et al., (2013).

H4. Global attention (and PEA coaching) will uniquely activate regions in the visual associative / temporal-parietal cortex whereas local attention (and NEA coaching) will activate regions in early visual / occipital cortex.

The purpose of the present study was to extend prior research (Jack et al., 2013) by empirically testing the proposition that coaching to the PEA and NEA are associated with global and local attention, respectively, as evidenced by conjunctive neural activation on associated tasks. The data reported in this paper were collected as part of a larger study examining a number of different research questions (Jack, Boyatzis, Abou Zeki, Passarelli, & Dawson, 2013b).

Method

Subjects

Forty-seven full time undergraduates participated in this study. An online pre-screen and scheduling tool (Experiment Management System, Sona Systems) was used to establish that subjects were right-hand dominant, native English speakers, had no neurological disorders or diseases, were not pregnant, did not experience claustrophobia, and were not declared Cognitive Science majors. Of the 65 who volunteered for the entire study of which this was a part, 14 were dropped due to high scores on the Depression, Anxiety, and Stress Scale (DASS-21), failing to attend sessions, claustrophobia, or previously undisclosed neurological disorders. fMRI data were obtained from a final total of 51 subjects (26 male, average age = 19.8 years). Four participants had incomplete imaging data, yielding a final sample size of 47 subjects. Subjects were compensated for their time at a rate of $10 to complete an initial questionnaire, and an additional $50 as well as a copy of a leadership book and a CD with a structural image of their brain if they completed the remaining study requirements. This research was approved by the appropriate local Institutional Review Board.

Design

Our hypotheses were tested using functional magnetic resonance imaging (fMRI) to quantify neural activity while subjects engaged in coaching and visual attention processing tasks. Consistent with the previous study, face-to-face coaching sessions were conducted prior to the fMRI scan. All subjects had one NEA coaching session and were randomly assigned to varying levels of the PEA (zero, one, two, or three face-to-face sessions or an asynchronous written session). By varying the levels of PEA treatment, we expanded previous work by disentangling prior coaching from scanner arousal. That manipulation produced interesting results in subcortical and ventromedial prefrontal regions associated with reward and parasympathetic arousal (Jack et al., 2013b). It did not influence arousal in the regions we describe here - hence, these arousals can be attributed to the video-simulated interactions in the scanner task alone.

Coaching conditions were kept consistent between the face-to-face and video-simulated scanner interactions. That is, the same coach who led the NEA session appeared in the scanner video making the NEA statements. The coaches were counterbalanced across conditions and gender to minimize coach-specific or gender effects. In order to standardize timing, all PEA sessions were conducted first and within one week of each other (in multiple session conditions), followed by the NEA session. fMRI scans were conducted within two weeks of the final session.

Face-to-face coaching session(s). Two experienced coaches of different genders were trained in the study protocol to conduct semi-structured interview coaching sessions. After introducing himself/herself, the coach in the PEA condition asked the anchor question: “If everything worked out ideally in your life, what would you be doing in 10 years?” This was followed with more specific probes if needed. In addition to this theme of hope or vision for the future, subjects who were assigned to two or three PEA sessions also discussed (2) compassion via people who have helped the student most in the past, and (3) mindfulness with a discussion of their current most important values.

In the NEA condition, the coach asked the anchor question: “What challenges have you encountered or do you expect to encounter in your experience here?” If needed, additional probes were used. The aim of the NEA interviews was not to create a hostile environment.

Rather, the aim was to keep the student focused on assessing their performance currently and anticipated in the future in terms of externally defined standards and what he/she should be doing to get closer to those standards. The coaches always maintained a polite and respectful tone.

fMRI tasks. In the scanner, each participant received six scans. The first two scans established the unique anatomical structure of that individual's brain, and allowed the functional data to be transformed to a standardized atlas space (711-2B, with coordinates approximating standard Talaraich space). The other five scans were functional scans, used to assess BOLD response to different task conditions. The first functional scan is not of relevance here, and involved participants viewing pictures of static faces. The next three functional scans required participants to engage in a simulated coaching task. The final functional scan required participants to engage in a global-local visual processing task.

The coaching task simulated PEA and NEA-based coaching interactions in a video-conference-style interaction between the participant and the coaches. The participant was presented with a total of 96 pre-recorded videos of the coaches making statements about the participant's educational experience or outlook on the future. These statements were developed around the themes of hope, compassion, mindfulness and playfulness in the PEA condition and lack thereof in the NEA condition (e.g. PEA: "I am excited about the possibilities my future holds," and NEA: "I am afraid I will not achieve what is expected of me"/NEA). Equal numbers of present and future-focused statements were included. Using a button press, subjects indicated the degree to which they agreed or disagreed with the statement on a four-point scale (1 = strongly disagree, 4 = strongly agree). As soon as the subject responded, a brief video clip played in which the coach thanked the participant for their response. Hence, each trial involved a pseudo-interactive exchange between the subject and one of the two interviewers.

The videos consisted of a face-on view of the head and shoulders of the coach, who maintained eye contact (i.e. looked at the camera) as s/he spoke. Each coach made statements in a tone congruent with the style of coaching session previously experienced by the participant with that coach (mean length = 5193.54 ms), followed by a 2-second fixation cross. Then subjects had 4 seconds to respond to the statement. After the response or the passing of 4 seconds, a short video with the interviewer thanking them for their response played (mean length = 2218.34 ms). A fixation of 100ms, 2000ms, or 4000ms was randomly inserted between each trial. Subjects underwent three fMRI runs of this task for 280 frames or 560 seconds. Each fMRI run comprised 32 experimental trials (16 of each condition, NEA and PEA) and 8 resting fixation periods of 15 seconds (Figure 1a).

The visual attention task consisted of a cued-version of the Navon figures task (Navon, 1977), which was used to localize global and local processing regions in the brain. Subjects were instructed to look for either the large (global) or component (local) letters in sets of 10 Navon figures. The large letters were either (1) R's and L's comprised of smaller letters (e.g. A, H, X) or (2) other letters (A, H, X) made up of small R's and L's (Figure 1b). Subjects responded to seeing the letter "R" with their right hand and the letter "L" with their left hand. One second was allotted to respond to each letter. If the participant responded before one second passed, the slide switched to a fixation cross for the remaining time. The first two trials of each type were considered practice. This task took 280 frames, or 560 seconds.

Insert Figure 1a &b about here

Experimental Design

The coaching task and analysis relied on an extended event design (i.e. an event which was long in time). For the sake of the analysis presented, we collapsed activity across the three phases of each event (video, response, and thank you). For the visual attention task, a blocked analysis and design was used (i.e. participants experienced blocks of trials in which they were required identify either local or global letters throughout the block). Task design also allowed for event-related analyses of the global-local task (i.e. there were random jitters in times between trials in the block). This analysis was also conducted and produced similar but statistically weaker findings than the block design analysis.

Image Acquisition

A 4-Tesla Siemens-Bruker hybrid research MRI scanner was used. Subjects experienced structural image acquisition (T1 and T2w), and five blood oxygenation level-dependent (BOLD) runs (TR = 2000, TE = 20, flip angle = 90º) containing 310 or 280 echo planar imaging (EPI) volumes each (one of these runs was for the purpose of a different study). BOLD EPI images consisted of 38 contiguous 3.8 mm slices, producing 3.8 mm cubic voxels. The experimental paradigm, presented using E-Prime 2.0 software, was projected onto a screen on the head coil and visible through an angled mirror adjusted to accommodate each participant. Responses from four buttons, two under the index and middle fingers of each hand, were recorded and time stamped by E-Prime 2.0.

Preprocessing was accomplished using software developed, tested, and maintained by Abraham Snyder at Washington University in St. Louis Medical School (for an overview, see https://vimeo.com/17012062). Dr. Synder consulted on the analysis). Motion was corrected across and within runs using a rigid-body rotation and translational algorithm. Spatial transforms were computed to realign BOLD images where they were moved into a common atlas space determined by coregistration of an average EPI image with the T2 weighted structural image. The T2 weighted structural image was aligned with the T1 weighted magnetization-prepared rapid-acquisition gradient echo (MP-RAGE) structural sequence. The T1 image was aligned with an average T1 atlas through a series of affine transformations. This atlas had been created specifically for the Bruker 4T magnet and was aligned to the Washington University in St. Louis 711-2B version of Talairach atlas space (Buckner et al., 2004). The BOLD images were then re-sampled into 3 mm isotropic voxels. Data was smoothed using a 2 voxel (6mm) FWHM Gaussian kernel. Subsequent analyses of BOLD data used a general linear model (GLM), modeling out baseline and linear trends, and assuming a standard hemodynamic response function. This analysis was conducted using the Washington University in St. Louis software, FIDL, created and maintained by Dr. Mark McAvoy.

Results

Behavioral Results

Behavioral results are reported for 46 subjects (data was corrupted for one subject). The behavioral results provide evidence of the efficacy of both the visual processing and coaching tasks. For the visual attention task overall accuracy on all trials was 96.82% (global = 97.94%, local = 95.90%). High accuracy on this task signifies that subjects were successful in their attempts to attend to the global or local features of the image. The average response time for all correct trials was 415.19 ms. As expected, subjects responded more quickly to global than local trials ($t = 11.42$, $p < .001$; $M_{global} = 392.43$ ms, $M_{local} = 434.35$ ms). For the coaching task, subjects agreed overall with statements in the coaching trials more than they disagreed ($M = 2.90$), and agreed with PEA coaching statements more than NEA coaching statements ($t = 13.02$,

$p < .001$, $M_{PEA} = 3.35$, $M_{NEA} = 2.45$). Average response time to statements was 656.76 ms, and subjects responded more quickly to PEA statements than to NEA statements ($t = -3.60$, $p < .001$, $M_{PEA} = 624.99$, $M_{NEA} = 689.65$).

Imaging Data Analysis

All reported findings were corrected for whole brain multiple comparison correction using a threshold and clustering criterion (Threshold z = >3, Cluster: number of contiguous voxels = > 17). These thresholds were established through monte-carlo simulations run on real fMRI data (McAvoy, Ollinger, & Buckner, 2001). Only brain regions surviving multiple comparison correction are reported. All reported findings are based on quantitative analysis and established inferential statistics. Cognitive conjunction analysis is an inferential technique for establishing that a brain region is activated by two statistically independent comparisons (Friston, Penny & Glaser, 2005; Price & Friston, 1997). In order to conduct a cognitive conjunction analysis, two contrasts are first calculated (e.g. PEA - NEA, global - local). Next, at each voxel the minimum z-score for the two contrasts is computed (i.e. the value assigned to each voxel is the lesser of the value revealed by the two contrasts). In standard cognitive conjunction (Price & Friston, 1997), the threshold for multiple comparison correction is decreased (divided by root 2) to reflect the increased probability of Type II error while holding Type 1 error at a reasonable level. In strict cognitive conjunction, the threshold for multiple comparison correction is not altered, allowing a stronger inference (i.e. researchers can state that they have independently established that the region is implicated in each of the contrasts; Nichols et al., 2005). However, strict cognitive conjunction is a highly conservative statistical test prone to Type II error (Friston, Penny & Glaser, 2005). Since there has been some controversy about which test is most appropriate, we report both findings. Notably, most areas identified by the standard cognitive conjunction analysis in our tests also included areas that passed strict cognitive conjunction. For these cases, the issue of Type I error has been ruled out, and the standard cognitive conjunction provides a more reasonable estimate of the extent of the regions which are involved in both contrasts.

The standard approach to this analysis (Price & Friston, 1997) revealed extensive overlap in cortical areas in the occipital (visual) cortex, as well as superior temporal cortex and medial parietal cortex (Table 1). A stricter statistical approach, advocated by some researchers (Nichols et al., 2005) but regarded as overly conservative by others (Friston, Penny, & Glaser, 2005), revealed eight regions, which were less spatially extensive but included all the key areas identified in the first analysis (Table 2). Taken together, these results suggest that hypotheses 1 and 2 were confirmed with limited Type I and Type II error.

Insert Table 1 & 2 about here

We also conducted a conjunction analysis in the opposite direction in order to determine the extent of overlap between NEA coaching and global attention as well as PEA coaching and local attention. Pairing the task conditions opposite to the predicted direction produced limited results (Table 3). Using the standard threshold (less strict), 1031 voxels showed overlap for global-NEA/local-PEA as compared to 3469 voxels for global-PEA/local-NEA. Moreover, there was no overlap at all for global-NEA/local-PEA using the strict threshold for conjunction analysis. This further supports hypotheses 1 and 2, that PEA coaching is associated with global attention and NEA coaching is associated with local attention at the neurobiological level.

Insert Table 3 about here

Figure 2 depicts overlapping brain regions in the two conditions for the entire brain. This figure depicts lateralization such that PEA/global activation (orange) was more extensive in the right hemisphere and NEA/local activation (blue) was more extensive in the left hemisphere, confirming hypothesis 3.

Insert Figure 2 about here

Using the same color-coding scheme as the previous figure, Figure 3 depicts greater activation in the posterior occipital lobe (e.g. left inferior occipital gyrus) for NEA/local. This region, also known as the primary visual cortex, is responsible for initial processing of precise visual stimuli. Activation for PEA/global was more anterior in the temporal lobe (e.g. middle temporal gyrus), a region known as the visual associative area. Together these results confirm hypothesis 4.

Insert Figure 3 about here

Discussion

We found support for all hypotheses, suggesting that coaching to the PEA activates neural regions associated with broadened, global attention whereas coaching to the NEA activates neural regions associated with focused, local attention. Based on the cognitive conjunction analyses, more than three times as much cortex showed overlap in the manner predicted (PEA/global and NEA/local) than in the other direction (Figure 4). Furthermore, lateralization of PEA/global in the right hemisphere and NEA/local in the left hemisphere is consistent with prior neuroimaging research on visual attention (Han et al., 2002; Martinez et al., 1997). The location of activation along the perceptual stream suggests that PEA coaching and global attention recruit neural regions in the visual associative cortex associated with imagination, whereas NEA coaching and local attention recruit areas associated with early sensory processing of component details (Ganis et al., 2004).

It is notable that we found such extensive overlap in the contrasts produced by such disparate tasks. On the one hand, the coaching task simulated a complex and contextualized social interaction, with no detectable difference in visual processing demands between the PEA and NEA conditions. On the other hand, the visual attention task was highly decontextualized, containing no social or emotional cues, and the conditions only differed in terms of their visual processing demands. That we nonetheless found extensive overlap between the two contrasts strongly supports our contention that attention processing style is a highly relevant factor in determining how people respond to different kinds of coaching. Furthermore, these different types of thinking cannot be simply attributed to differences in emotional tone between the coaching conditions, since emotional tone was absent from the visual attention task and cannot account for the differences in recruitment in brain areas seen for global and local task conditions. Rather, it must be that the two coaching styles examined elicit fundamentally different types of attention processing.

Insert Figure 4 about here

These findings have implications for the moment-by-moment interactions that comprise coaching relationships. The extent to which these interactions evoke global or local attention may affect key coaching processes such as information processing and goal construal (Förster & Dannenberg, 2010). The relationship between PEA-NEA coaching and global-local attention may also be fundamental to understanding how individuals go about regulating their own behavior. Given the previously established empirical links between visual attention and self-regulatory focus (Förster & Higgins, 2005), it follows that coaching to the PEA would elicit a promotion focus (global) whereas coaching to the NEA elicits a prevention focus (local). A prevention focus may help an individual initiate goal-relevant action more quickly and decrease the likelihood of getting distracted by other things (Frietas et al., 2012). However, a promotion focus would be most effective at helping an individual adopt new goals, persist at them, and find enjoyment in striving toward them (Frietas et al., 2012; Freitas, & Higgins, 2002; Sue-Chan et al., 2012). Additional research is needed to confirm these assumptions. Furthermore, future research may seek to triangulate the present results with studies of real-time coaching interactions as well as extend them by testing the effects of global and local attention on coaching-related phenomena such as interpretation of feedback, decision-making, and goal-related behavior.

Limitations

A number of limitations to our study should be noted. First, the temporal orientation of coaching to the PEA versus coaching to the NEA may play a role in our results. Coaching to the PEA leans toward the future, but also engages reflection and discussion of people who have helped a person in the past and their present core values. The NEA leans toward the present, but it also addresses anticipated problems in the future. Research examining the effect of imagining an event (e.g. locking a door) in the distant versus near future demonstrated that distant events were associated with higher-level construals (e.g. securing the house) whereas proximal events were associated with lower-level construals (e.g. putting the key in the lock; Trope & Liberman, 2003). We attempted to control for temporal effects in the coaching task by including an equal number of statements that were focused on the past, present, and future in each coaching condition. Further research is needed to tease apart the temporal domain to determine if it has an effect on neural activation.

Second, there is evidence that the positive-global and negative-local association may be dispositional. Trait anxiety and depression have been associated with a local bias, whereas positive mood and optimism have been associated with a global bias (and inversely related to a local bias; Basso, Schefft, Ris, & Dember, 1996: Derryberry & Reed, 1998). In the current study, individuals with high levels of depression, anxiety, and stress were excluded from participation. Future research may want to consider if and how these traits moderate the relationship between coaching and attention.

Third, it is widely noted that fMRI represents a measure of neural processing which is both indirect (e.g. dependent on the existence of a reliable vascular response to neural activity) and correlational (e.g. might reflect neural activity which is not necessary for completion of the given task). While both these limitations are present for this and for all fMRI research, it is worth noting that experimental work establishes that fMRI is a highly reliable measure of neural activity (Logothetis, Pauls, Augath, Trinath, & Oeltermann, 2001), and convergent evidence from TMS and lesion studies presents little reason to suppose there is any widespread tendency for incidental neural activation to occur (Sakai, Noguchi, Takeuchi & Watanabe, 2002).

Contending with Issues in Neuroscientific Methods

The second objective of this paper was to illustrate that sound neuroimaging studies can help advance management understanding when critical issues are handled appropriately. Specifically, we respond to calls for hypothesis-driven analyses, replication, and careful inferences as well as a caution against reductionism. We believe this study is a positive example of how these challenges can be addressed. First, this study tested theory-driven hypotheses within an overall research design that was also theory-driven, which are desired features of organizational neuroscience research (Lee, Senior & Butler, 2012). We integrated psychological theory (i.e. ICT, attention) with neuroscientific theory (i.e. visual processing) to arrive at our hypotheses and a sound, well-reasoned method for testing them.

Second, this study replicated and extended a prior study (Jack et al., 2013) in two key ways. First, the sample size was increased to accommodate expanded coaching treatment levels. This helps with the issue of low statistical power, which is challenged by the relatively small sample sizes typically used in fMRI studies due to the costs (Lee et al., 2012). Second, a well-documented Navon figures task was introduced to increase confidence in our interpretation of results through a more appropriate data analytic process (cognitive conjunction) that reduced our reliance on reverse inference. Together these features address Lindebaum's (2015) call for future research to provide direct replication in order to achieve greater confirmatory power.

Finally, contextualizing this study in the broader program of research of which it is a part evinces our 'critical realist' approach to neuroscience as advocated by Healey and Hodgkinson (2014) whereby neurobiological processes are viewed as a contributory, not primary, cause of behavior in organizations. Neuroimaging is one of a variety of methods that have been used to examine differences between coaching to the PEA and NEA. Other studies examined coaching to the PEA and NEA in relation to affect and regulatory focus in field experiments (Howard, 2015; Passarelli, 2014), leader development and performance in field studies (Van Oosten, 2013), and treatment adherence in other helping fields like medicine (Khawaja, 2010). Moreover, within this study we recognize that relational and psychological processes are linked to the neural activations we report. In other words, the neural activations are not a "sole cause" but an important component of the effect on the person being coached. This reflects our effort to situate our work in a productive space between reductionist and anti-reductionist perspectives (Healey & Hodgkinson, 2014).

Conclusion

Critiques of the turn toward neuroscience in organizational research play an important role in moving the field forward. Cautionary criticism highlights theoretical, methodological and ethical challenges that must be addressed in order for neuroscience to inform the field of management. Here we provide an example of how to integrate theory at the psychological and neurobiological levels, reduce reliance on reverse inference through design and data analytic techniques, and move beyond phrenology with by adopting a broader view of cognitive function. In doing so, we have presented results from a study that allowed inferences to be made regarding a key phenomenon in organizations - coaching.

Results of an fMRI study point to the notion that an individual's attention – whether they see the forest or the trees – is likely to be influenced by social interaction with a coach. Extensive overlap in neural activation in the right hemisphere and visual associative cortex was found for PEA-coaching and global attention. NEA-coaching and local attention shared overlap in the left hemisphere and early visual area in the occipital lobe. This suggests a neurobiological basis for perceptual differences arising from different types of coaching conversations.

Whether managers take a coaching role or external coaches are hired to intervene, coaching individuals to develop involves inspiring them to see new possibilities for thinking, feeling, and behaving that will increase their effectiveness (Boyatzis, Smith, & Blaize, 2006; Gregory & Levy, 2011). The neurobiological evidence presented here links the approach of the coach to the coachee's attentional focus. Specifically, this study demonstrates that neural correlates of coaching to the PEA, activated by emphasizing the coachee's ideal self, personal vision, core values and compassion are associated with neural correlates of global visual processing. Individuals who are in a PEA-state are better able to scan the broad environment and perceive emerging themes. They appear more open to new ideas. This broadened state of attention has been linked through other research to sophisticated and resilient pursuit of complex goals (Fredrickson & Branigan, 2005; Fredrickson & Joiner, 2002). In contrast, neural correlates of coaching to the NEA, activated by emphasizing the coachee's real self, are associated with neural correlates of narrowed visual attention, which may result in a lack of scanning, creativity, and openness. Discerning the neural mechanisms that underlie these processes offer a deeper understanding of how individuals respond to coaching.

References

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global-local visual processing. *Journal of the International Neuropsychological Society*, *2*(3), 249-255. doi:10.1017/S1355617700001193

Bono, J. E., Purvanova, R. K., Towler, A. J., & Peterson, D. B. (2009). A survey of executive coaching practices. *Personnel Psychology, 62*(2), 361-404. doi:10.1111/j.1744-6570.2009.01142.x

Boyatzis, R. E. (2008). Leadership development from a complexity perspective. *Consulting Psychology Journal*, *60*(4), 298-313. http://dx.doi.org/10.1037/1065-9293.60.4.298

Boyatzis, R. E., & Akrivou, K. (2006). The ideal self as the driver of intentional change. *Journal of Management Development, 25*(7), 624-642. doi:10.1108/02621710610678454

Boyatzis, R.E., Passarelli, A.M., Koenig, K., Lowe, M., Mathew, B., Stoller, J.K., & Phillips, M. (2012). Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders. *Leadership Quarterly, 23*, 259-272. doi:10.1016/j.leaqua.2011.08.003

Boyatzis, R. E., Rochford, K., & Taylor, S. E. (2015). The role of the positive emotional attractor in vision and shared vision: Toward effective leadership, relationships, and engagement. *Frontiers in Psychology, 6*(670), 1. doi:10.3389/fpsyg.2015.00670

Boyatzis, R. E., Smith, M. L., & Beveridge, A. J. (2012). Coaching with compassion: Inspiring health, well-being, and development in organizations. *Journal of Applied Behavioral Science, 49*(2), 153-178. doi:10.1177/0021886312462236

Boyatzis, R. E., Smith, M. L., & Blaize, N. (2006). Developing sustainable leaders through coaching and compassion. *Academy of Management Learning & Education, 5*(1), 8-24.

Crowe, E. & Higgins, E.T. (1997). Regulatory focus and strategic inclinations: Promotion and prevention in decision-making. *Organizational Behavior and Human Decision Processes, 69*(2), 117-132. doi:10.1006/obhd.1996.2675

Derryberry, D. & Reed, M.A. (1998). Anxiety and attentional focusing: Trait, state, and hemispheric influences. *Personality and Individual Differences, 25*, 745-761. doi:10.1016/S0191-8869(98)00117-2

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

Downing, P. E. (2005). Domain specificity in visual cortex. *Cerebral Cortex, 16(10),* 1453–1461. doi:10.1093/cercor/bhj086.

Fink, G. R., Halligan, P. W., Marshall, J. C., Frith, C. D., Frackowiak, R. S. J., & Dolan, R. J. (1996). Where in the brain does visual attention select the forest and the trees?. *Nature, 382*, 626-628. doi:10.1038/382626a0

Förster, J. (2012). GLOMO(sys): The how and why of global and local processing. *Current Directions in Psychological Science, 21(1),* 15–19. doi:10.1177/0963721411429454

Förster, J., & Dannenberg, L. (2010). GLOMOsys: A systems account of global versus local processing. *Psychological Inquiry, 21*(3), 175-197. doi: 10.1080/1047840X.2010.487849

Förster, J. & Higgins, E.T. (2005). How global versus local perception fits regulatory focus. *Psychological Science, 16*(9), 631-636. doi:10.1111/j.1467-9280.2005.01586.x

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*(3), 300-319. http://dx.doi.org/10.1037/1089-2680.2.3.300

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19(3),* 313-332. doi:10.1080/02699930441000238

Freitas, A. L., & Higgins, E. T. (2002). Enjoying goal-directed action: The role of regulatory fit. *Psychological Science, 13*(1), 1-6. doi:10.1111/1467-9280.00401

Friston, K. J., Penny, W. D., & Glaser, D. E. (2005). Conjunction revisited. *NeuroImage, 25,* 661-667. doi:10.1016/j.neuroimage.2005.01.013

Ganis, G., Thompson, W. L., & Kosslyn, S. M. (2004). Brain areas underlying visual mental imagery and visual perception: an fMRI study. *Cognitive Brain Research, 20(2),* 226-241. doi: 10.1016/j.cogbrainres.2004.02.012

Gasper, K. & Clore, G.L. (2002). Attending to the big picture: Mood and global processing of visual information. *Psychological Science, 13*(1), 34-40. doi:10.1111/1467-9280.00406

Han, S., Weaver, J. A., Murray, S. O., Kang, X., Yund, E. W., & Woods, D. L. (2002). Hemispheric asymmetry in global/local processing: Effects of stimulus position and spatial frequency. *Neuroimage, 17(3),* 1290–1299. doi:S1053811902912553

Healy, M. P.& Hodgkinson, G. P. (2014). *Human Relations.* 67(7). 765-792. doi: 10.1177/0018726714530014

Higgins, E. T. (1987). Self-discrepancy: a theory relating self and affect. *Psychological review*, *94*(3), 319.

Higgins, E. T., Idson, L. C., Freitas, A. L., Spiegel, S., & Molden, D. C. (2003). Transfer of value from fit. *Journal of Personality and Social Psychology*, *84*(6), 1140. http://dx.doi.org/10.1037/0022-3514.84.6.1140

Higgins, E. T., Roney, C. J., Crowe, E., & Hymes, C. (1994). Ideal versus ought predilections for approach and avoidance distinct self-regulatory systems. *Journal of personality and* *social psychology*, *66*(2), 276. http://dx.doi.org/10.1037/0022-3514.66.2.276

Howard, A. (2006). Positive and negative emotional attractors and intentional change. *Journal of Management Development, 25*(7), 657-670. doi:10.1108/02621710610678472

Howard, A. (2015). Coaching to vision versus coaching to improvement needs: A preliminary investigation on the differential impacts of fostering positive and negative emotion during real time executive coaching sessions. *Frontiers in Psychology*. doi:10.3389/fpsyg.2015.00455

Jack, A.I., Boyatzis, R.E., Khawaja, M.S., Passarelli, A.M., & Leckie, R.L. (2013). Visioning in the brain: An fMRI study of inspirational coaching and mentoring. *Social Neuroscience, 8*(4), 369-384. doi:10.1080/17470919.2013.808259

Jack, A.I., Boyatzis, R.E., Abou Zeki, D., Passarelli, A.M., & Dawson, A.J. (2013b, April). *Coaching with compassion alters neural mechanisms of stress processing.* Poster presented at Research ShowCASE, Case Western Reserve University, Cleveland, OH.

Khawaja, M. (2010). The mediating role of positive and negative emotional attractors between psychosocial correlates of doctor-patient relationship and treatment of Type II diabetes. Doctoral Dissertation, Case Western Reserve University; Cleveland, Ohio.

Lamb, M. R., Robertson, L. C., and Knight, R. T. 1989. Attention and interference in the processing of global and local information: Effects of unilateral temporal-parietal junction lesions. *Neuropsychologia, 27(*4), 471–483. doi:10.1016/0028-3932(89)90052-3

Lamb, M. R., Robertson, L. C., and Knight, R. T. (1990). Component mechanisms underlying the processing of hierarchically organized patterns: Inferences from patients with unilateral cortical lesions. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*(3), 471–483. http://dx.doi.org/10.1037/0278-7393.16.3.471

Lamb, M. R., & Yund, E. W. (1996). Spatial frequency and attention: Effects of level-, target-, and location-repetition on the processing of global and local forms. *Perception & Psychophysics*, *58*(3), 363-373.

Lee, N. Senior, C. & Butler, M. J.R. (2012). The domain of organizational cognitive neuroscience: Theoretical and empirical challenges. *Journal of Management. 38(*4). 921-931.

Lindebaum, D. (2015). Critical essay: Building new management theories on sound data? The case of neuroscience. *Human Relations*. doi: DOI: 10.1177/0018726715599831

Lindebaum, D. & Zundel, M. (2013). Not quite a revolution: Scrutinizing organizational neuroscience in leadership studies. *Human Relations.* 66(6), 857-877.

Logothetis, N.K., Pauls, J., Augath, M., Trinath, T., & Oeltermann, A. (2001). Neurophysiological investigation of the basis of the fMRI signal. *Nature, 412*, 150-157. doi: 10.1038/35084005

Lord, R., & Hall, R. (2005). Identity, deep structure and the development of leadership skill. *Leadership Quarterly, 16*, 591-615. doi:10.1016/ j.leaqua.2005.06.003

McAvoy, M. P., Ollinger, J. M., & Buckner, R. L. (2001). Cluster size thresholds for assessment of significant activation in fMRI. *Neuroimage*, *13*(6), 198. doi: 10.1016/S1053-8119(01)91541-1

Macrae, C. N., & Lewis, H. L. (2002). Do I know you? Processing orientation and face recognition. *Psychological Science, 13*(2), 194–196. doi: 10.1111/1467-9280.00436

Martinez, A., Moses, P., Frank, L., Buxton, R., Wong, E., & Stiles, J. (1997). Hemispheric asymmetries in global and local processing: Evidence from fMRI. *Neuroreport, 8(7),* 1685–1689.

Mogilner, C., Aaker, J.L, & Pennington, G.L. (2008). Time will tell: The distant appeal of promotion and imminent appeal of prevention. *Journal of Consumer Behavior, 34*, 670-681. http://dx.doi.org/10.1086/521901

Molden, D. C., & Hui, C. M. (2011). Promoting de-escalation of commitment: a regulatory-focus perspective on sunk costs. *Psychological Science, 22(1),* 8-12. doi:10.1177/0956797610390386

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*, 353-383. doi:10.1016/0010-0285(77)90012-3

Nichols, T., Brett, M., Anderson, J., Wager, T., & Poline, J. (2005). Valid conjunction inference with minimum statistic. *NeuroImage, 25,* 653-660.doi:10.1016/j.neuroimage.2004.12.005

Passarelli, A.M. (2014). *The heart of helping: Psychological and physiological effects of contrasting coaching interactions.* (Unpublished doctoral dissertation). Case Western Reserve University, Cleveland, OH.

Passarelli, A. M. (2015). Vision-based coaching: Optimizing resources for leader development. Frontiers in Psychology, 6. Retrieved from http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00412/abstract

Pelphrey, K. A. (2005). Neural basis of eye gaze processing deficits in autism. *Brain, 128(5),* 1038–1048. doi:10.1093/brain/awh404

Poldrack, R. A. (2011). Inferring mental states from neuroimaging data: from reverse inference to large-scale decoding. N*euron, 72(*5), 692-697. doi:10.1016/j.neuron.2011.11.001S0896-6273(11)00989-5 [pii]

Price, C. J., & Friston, K. J. (1997). Cognitive conjunction: A new approach to brain activation experiments. *NeuroImage, 5,* 261-270. doi:10.1006/nimg.1997.0269

Rauschenberger, R., & Yantis, S. (2001). Attentional capture by globally defined objects. *Perception & Psychophysics*, *63*(7), 1250-1261. doi:10.3758/BF03194538

Robertson, L. C., Lamb, M. R., & Knight, R. T. (1988). Effects of lesions of temporal-parietal junction on perceptual and attentional processing in humans. *The Journal of Neuroscience*, *8*(10), 3757-3769.

Sakai, K. L., Noguchi, Y., Takeuchi, T., & Watanabe, E. (2002). Selective priming of syntactic processing by event-related transcranial magnetic stimulation of Broca's area. *Neuron*, *35*(6), 1177-1182. doi: http://dx.doi.org/10.1016/S0896-6273(02)00873-5

Sue-Chan, C., Wood, R. E., & Latham, G. P. (2012). Effect of a coach's regulatory focus and an individual's implicit person theory on individual performance. *Journal of Management, 38*(3), 809-835. doi:10.1177/0149206310375465

Taylor, S. N. (2006). Why the real self is fundamental to intentional change. *Journal of Management Development, 25*(7), 643-656. doi:10.1108/02621710610678463

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological Review, 110,* 403-421.

Van Oosten, E. (2013). *The impact of emotional intelligence and executive e coaching on leader effectiveness.* Unpublished PhD dissertation, Case Western Reserve University; Cleveland, OH.

Weissman, D. H., & Woldorff, M. G. (2005). Hemispheric asymmetries for different components of global/local attention occur in distinct temporo-parietal loci. *Cerebral Cortex*, *15*(6), 870-876. doi:10.1093/cercor/bhh187

Zhang, S., Cornwell, J. F. M., & Higgins, E. T. (2014). Repeating the past: Prevention focus motivates repetition, even for unethical decisions. *Psychological Science, 25*(1), 179-187. doi:10.1177/0956797613502363

Table 1. Overlapping Brain Regions, Standard Conjunction Analysis

Location of Center of Mass	Talairach Coordinates (x, y, z)	Extent (voxels)	Condition
Left Cerebrum, Occipital Lobe, **Fusiform Gyrus**, Gray Matter, Brodmann area 18, Range=2	(-20, -89, -9)	812	NEA/local
Right Cerebrum, Occipital Lobe, **Lingual Gyrus**, Gray Matter, Brodmann area 18, Range=0	(27, -96, -3)	234	NEA/local
Right Cerebrum, Sub-lobar, **Insula**, Gray Matter, Brodmann area 13, Range=1	(31, 14, -6)	60	NEA/local
Right Cerebrum, Frontal Lobe, **Superior Frontal Gyrus**, Gray Matter, Brodmann area 9, Range=0	(9, 59, 26)	17	NEA/local
Left Cerebrum, Temporal Lobe**, Caudate**, Gray Matter, Caudate Tail, Range=3	(-35, -38, 6)	150	PEA/global
Right Cerebrum, Occipital Lobe, **Cuneu**s, Gray Matter, Brodmann area 30, Range=0	(14, -67, 12)	537	PEA/global
Left Cerebrum, Occipital Lobe, **Middle Occipital Gyrus**, Gray Matter, Brodmann area 19, Range=4	(-36, -69, 13)	454	PEA/global
Left Cerebrum, Sub-lobar, **Claustrum,** Gray Matter, *, Range=1	(-38, -20, -4)	17	PEA/global
Right Cerebrum, Temporal Lobe, **Superior Temporal Gyrus**, Gray Matter, Brodmann area 22, Range=3	(51, -52, 18)	618	PEA/global
Left Cerebrum, Frontal Lobe, **Middle Frontal Gyrus**, Gray Matter, Brodmann area 8, Range=3	(-22, 22, 35)	156	PEA/global
Left Cerebrum, Sub-lobar, **Insula**, Gray Matter, Brodmann area 13, Range=1	(-37, -12, 13)	17	PEA/global
Right Cerebrum, Parietal Lobe**, Precuneus**, Gray Matter, Brodmann area 7, Range=1	(1, -48, 49)	247	PEA/global
Left Cerebrum, Frontal Lobe, **Sub-Gyral,** White Matter (No gray matter found within +/- 5mm)	(-35, -18, 31)	35	PEA/global

Note: Location of center of mass includes output from Talairach Client set to search nearest gray matter to given coordinates.

Table 2. Overlapping Brain Regions, Strict Conjunction Analysis

Location of Center of Mass	Talairach Coordinates (x, y, z)	Extent (voxels)	Condition
Left Cerebrum, Occipital Lobe, **Inferior Occipital Gyrus**, Gray Matter, Brodmann area 17, Range=1	(-19, -94, -6)	173	NEA/local
Right Cerebrum, Occipital Lobe, **Lingual Gyrus**, Gray Matter, Brodmann area 18, Range=0	(28, -97, -3)	43	NEA/local
Right Cerebrum, Limbic Lobe, **Parahippocampal Gyrus**, Gray Matter, Brodmann area 19, Range=1	(17, -49, -5)	26	PEA/global
Right Cerebrum, Occipital Lobe, **Lingual Gyrus**, Gray Matter, Brodmann area 18, Range=0	(11, -68, 1)	27	PEA/global
Right Cerebrum, Occipital Lobe, **Middle Temporal Gyrus**, Gray Matter, Brodmann area 19, Range=2	(43, -62, 13)	61	PEA/global
Left Cerebrum, Temporal Lobe, **Middle Temporal Gyrus**, Gray Matter, Brodmann area 39, Range=4	(-38, -71, 16)	42	PEA/global
Right Cerebrum, Parietal Lobe, **Inferior Parietal Lobule**, Gray Matter, Brodmann area 40, Range=1	(60, -35, 28)	41	PEA/global
Right Cerebrum, Parietal Lobe, **Precuneus**, Gray Matter, Brodmann area 7, Range=0	(4, -49, 50)	41	PEA/global

Note: Location of center of mass includes output from Talairach Client set to search nearest gray matter to given coordinates.

Table 3. Overlapping Brain Regions, Opposite Conjunction (global-NEA, local-PEA)

Location of Center of Mass	Talairach Coordinates (x, y, z)	Extent (voxels)	Condition
Left Cerebellum, Posterior Lobe, **Pyramis**, Gray Matter, Range=0	(-19, -77, -34)	38	NEA/global
Left Cerebrum, Temporal Lobe, **Middle Temporal Gyrus**, Gray Matter, Brodmann area 22, Range=3	(-52, -40, 0)	203	NEA/global
Left Cerebrum, Frontal Lobe, **Inferior Frontal Gyrus**, Gray Matter, Brodmann area 47, Range=5	(-41, 33, 2)	38	NEA/global
Right Cerebrum, Temporal Lobe, **Middle Temporal Gyrus**, Gray Matter, Brodmann area 22, Range=0	(65, -37, 5)	30	NEA/global
Left Cerebrum, Occipital Lobe, **Cuneus,** Gray Matter, Brodmann area 18, Range=0	(-5, -95, 14)	30	NEA/global
Left Cerebrum, Frontal Lobe, **Inferior Frontal Gyrus,** Gray Matter, Brodmann area 44, Range=2	(-49, 10, 19)	33	NEA/global
Left Cerebrum, Temporal Lobe, **Superior Temporal Gyrus**, Gray Matter, Brodmann area 39, Range=1	(-56, -62, 19)	33	NEA/global
Right Cerebrum, Frontal Lobe, **Middle Frontal Gyrus**, Gray Matter, Brodmann area 9, Range=0	(48, 14, 27)	18	NEA/global
Left Cerebrum, Frontal Lobe, **Superior Frontal Gyrus**, Gray Matter, Brodmann area 8, Range=0	(-2, 32, 44)	113	NEA/global
Left Cerebrum, Frontal Lobe, **Middle Frontal Gyrus,** Gray Matter, Brodmann area 9, Range=3	(-40, 10, 40)	67	NEA/global
Right Cerebrum, Parietal Lobe, **Inferior Parietal Lobule**, Gray Matter, Brodmann area 40, Range=0	(37, -39, 48)	175	NEA/global
Left Cerebrum, Frontal Lobe, **Middle Frontal Gyrus**, Gray Matter, Brodmann area 6, Range=0	(-38, -1, 49)	20	NEA/global
Left Cerebrum, Frontal Lobe, **Precentral Gyrus**, Gray Matter, Brodmann area 4, Range=0	(-34, -24, 51)	30	PEA/local
Left Cerebrum, Occipital Lobe, **Middle Occipital Gyrus**, Gray Matter, Brodmann area 19, Range=5	(-27, -77, 12)	97	PEA/local
Right Cerebrum, Occipital Lobe, **Middle Occipital Gyrus,** Gray Matter, Brodmann area 19, Range=3	(31, -79, 11)	80	PEA/local

Note: Location of center of mass includes output from Talairach Client set to search nearest gray matter to given coordinates.

Figure 1a. Coaching task timing

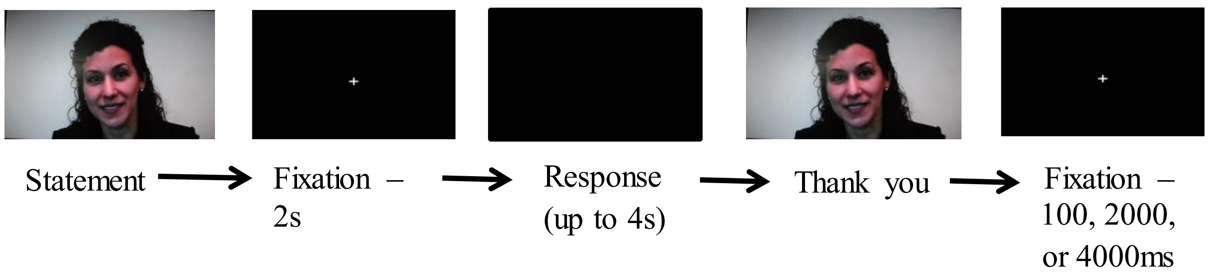

Figure 1b. Navon figures task (local cue)