

Neuroscience of engagement

David Rock^{1,2,3} and Dr. Yiyuan Tang^{4,5,6,7}

¹CEO, Results Coaching Systems International, Sydney, Australia

²Faculty, CIMBA

³Co-founder, NeuroLeadership Institute: Editor, NeuroLeadership Journal

⁴Institute of Neuroinformatics, Dalian Univ. Tech., Dalian, China

⁵Department of Psychology, University of Oregon, USA

⁶Institute of Psychology, the Chinese Academy of Sciences, Beijing, China

⁷Center for Social and Organizational Behavior,
Graduate University of Chinese Academy of Sciences, Beijing, China

davidrock@workplacecoaching.com

yiyan@uoregon.edu

Introduction

Workplace engagement involves the degree to which people put in discretionary effort and care into their job. Up until now, research on engagement has focused mostly on the degree to which engagement impacts organizational performance (Conference Board, 2006). Also, there has been research into the way engagement varies across different organizations and different countries (Gallup, N.D.) However, no research has been done to identify the underpinning neurological drivers of engagement, its effects on various brain networks, and how we might measure engagement more objectively through neural or biological markers.

Recent neuroscience research has begun to provide insights into the neurological drivers of behavior in the social environment (Lieberman, 2008; Lieberman and Ochsner, 2001; Rock, 2008; Ringleb and Rock, 2008; Tang and Posner, 2008). In this paper we will draw on neuroscience research to explore these five questions:

1. What is the neural basis of engagement?
2. What are the neural drivers that enhance and decrease engagement?
3. What are the levels of engagement from a neural perspective?
4. What effect does increasing or decreasing engagement have on the brain and our wider biology?
5. What neural markers might be used to more accurately measure engagement and the effects of engagement interventions?

Overall, we believe that understanding the neuroscience of engagement is more than just an interesting discussion, but will open up insights into how to more accurately and

effectively measure and improve employee engagement across all types of organizations. While there is much research still to do, this paper can provide a theoretical foundation that can help shape future research.

Engagement is something the employee has to offer: it cannot be 'required' as part of the employment contract.

The neural basis of engagement

Engagement in this paper relates to the idea of workplace engagement. A definition of engagement from a US-based organizational research firm is:

'A heightened emotional connection that an employee feels for his or her organization, that influences him or her to exert greater discretionary effort to his or her work' (Conference Board, 2006).

A definition from a UK-based organizational research firm is:

'A combination of commitment to the organisation and

its values, plus a willingness to help out colleagues (organisational citizenship). It goes beyond job satisfaction and is not simply motivation. Engagement is something the employee has to offer: it cannot be 'required' as part of the employment contract' (CIPD, 2008)

Neuroscientist Evian Gordon, in one of the largest meta-analyses of brain research in the world, proposes that the organizing principle of the brain is to minimize danger and maximize reward (Gordon, 2008). In this paper we propose that the neural basis of engagement is closely linked to this threat/reward function. The basis for this belief is the extensive literature emerging about the reward/threat response (Elliot, 2008), and the fairly obvious common themes emerging when comparing engagement research to neuroscience research. For example, in the reward state, versus the threat state, people:

- Experience increased cognitive resources (Arnsten, 1998)
- Are generally more creative (Friedman and Förster, 2001)
- Solve more problems with the insight phenomenon, which is required for complex problem solving (Jung-Beeman *et al.*, 2009)
- Come up with more ideas for actions (Frederickson, 2001)
- Have a wider field of perceptual view (Schmitz, De Rosa and Anderson, 2009)

These findings are consistent with definitions of engagement, where people are more capable overall at making decisions and solving problems (Conference Board, 2006).

...an employee of a bank who has a high level of engagement would experience high levels of activation of their reward and self-regulation circuitry when at work...

We propose that the neural basis of engagement can be defined by the average levels of activation of the brain's reward and self-regulation circuitry when thinking about or

bank who has a high level of engagement would experience high levels of activation of their reward and self-regulation circuitry when at work; when they worked, they would have good levels of dopamine in their executive attention or self-regulation networks and reward circuitry including prefrontal region, anterior cingulate cortex (ACC), striatum and only moderate levels of activation of the threat circuitry. When an employee is engaged, there is increased activation of reward and self-regulation circuitry in the brain, such as released by the striatum and maintained by the self-control networks. The striatum releases dopamine directly into the prefrontal cortex, ACC, and other associated regions positively affecting a wide range of cognitive and emotional functions through increasing brain resources and functional connectivity (Arnsten, 1998; Tang and Posner, 2009; Tang *et al.*, 2009). We explore the impact of engagement and disengagement in detail later in this document.

The same principle can apply to thinking about not just an overall job but also to participating in any particular task. It is possible that an employee could be overall not engaged, but have one specific task that they find engaging. Perhaps the bank employee doesn't like dealing with their boss or the paperwork but is engaged when they deal with customers and are able to help them solve their problems. In this way, overall engagement can be thought of as the *average level* of reward experienced by an employee in their task, but individual tasks could also be measured as well, both one-off and averaged over time. It should be noted that an individual's overall engagement in life could be assessed, which would include levels of engagement when at work, at home or in leisure activities. It would be interesting in future research to see whether people had consistent levels within these domains, and the impact that increasing engagement in one area may have on others.

We propose that the neural basis of disengagement can be defined by the average levels of activation of the brain's threat circuitry. Threat circuitry is not just fear. It includes anything that is an avoid response, including sadness, anxiety, lack of safety, depression and mind wandering (at the extreme this involved attention deficit disorders or ADD). Activation of threat circuitry has a surprising effect at very low levels (Friedman and Förster, 2001) including when subtly primed and thus impacting beneath conscious awareness. This disengagement state can occupy large amounts of brain resources and decrease the efficiency of attention resources.

Disengagement, like engagement, can be measured across an entire job, or within a specific task. We recognize that threat can indeed be effective for increasing noradrenaline levels and thereby focusing attention (Arnsten, 1998). This type of engagement would not be considered within this framework as a positive engagement; it would involve the

(see below). This type of engagement can be effective short term for executing specific projects, but tends to be narrow in view, inhibiting creative thinking (Beeman, 2009), inducing mental fatigue (Tang and Posner, 2009) and comes with long term consequences such as negatively impacting overall health due to increased cortisol (Boudarene, Legros and Timsit-Berthier, 2002).

Threat circuitry is not just fear. It includes anything that is an avoid response...

Neural drivers that enhance and decrease engagement

With the idea of the threat and reward response as the basis of engagement, the question becomes 'what are the issues that generally create high levels of rewards or threats, especially in social environments?' The answer to this question, we propose, is largely to be found in the social cognitive and affective neuroscience literature. The SCARF model (Rock, 2008) summarizes a wide range of social cognitive and affective neuroscience findings into five domains of threat or reward. The five domains are Status, Certainty, Autonomy, Relatedness and Fairness. These five domains are environment factors that people keep track of, in a similar way to tracking levels of food or water, and using similar circuits in the brain (Lieberman, 2008). We propose that engaged employees are experiencing high levels of positive rewards in the SCARF domains, and disengaged employees are experiencing high levels of threats in the SCARF domains.

The research that supports this proposition involved looking over engagement models and meta-summaries of engagement models, and finding that the elements of each model fit into one of the categories of SCARF. For example, in one of the most common engagement models; The Gallup Organization's Q12; six out of 12 questions related to Status, one to certainty, one to autonomy, two to relatedness and one to fairness. (See Appendix 1)

On the other hand, engagement is also indexed by a balanced brain-body state including occupied, effortless, joyful feeling and being flow (Tang, 2009) which we will discuss below.

What are the levels of engagement from a neural perspective?

Gallup organization (Gallup, N.D.) has identified three levels of engagement:

- Actively Disengaged
- Not Engaged
- Engaged

We propose a model with five levels, that link to the threat/reward response.

Actively disengaged	<i>A high average threat state</i>
Disengaged	<i>An average threat state</i>
Neutral	<i>Mid way between threat and reward states</i>
Engaged	<i>On average a reward state</i>
Deeply engaged	<i>A strong average reward state</i>

We have added 'Disengaged' and 'Neutral' to have a more robust model for researching engagement. We propose adding 'Deeply engaged' to take into account a higher level of engagement that may be necessary to offset the deep levels of the threat response that leaders experience, called 'power stress' (Boyatzis, Smith and Blaize 2006). By experiencing deep engagement, which is a strong average reward response, leaders develop a type of resilience to power stress, similar to the ideas of Psychological Capital (Luthans, Youssef and Avolio, 2007). Deep engagement is a level of engagement which is often seen in entrepreneurs who are inspirational, visionary leaders, or people who are highly successful at engaging others.

Deep engagement is a level of engagement which is often seen in entrepreneurs who are inspirational, visionary leaders...

We propose that deep engagement is an experience that occurs when people experience rewards from all five domains of SCARF. One way to do this is when you are undertaking tasks that you perceive improve the greater good, by improving some kind of social condition. In this

way, you are improving your status in the eyes of yourself and others. You are decreasing uncertainty, by solving some kind of social problem that did not have a solution. You are acting autonomously, making choices instead of complaining about the social problem. You are connecting with other people to facilitate change and you are reducing unfairness in the world in some way. These 'social problems' can be as simple and local as improving the way people communicate in a lunchroom, such that people start to share personal histories and connect more. Or they can be projects that deeply affect the wellbeing of communities.

...organizations committed to improving the world achieve more than those with a vision to just beat the competition...

This idea of socially-valuable projects being deeply rewarding links to organizational research on high performing cultures, showing that organizations committed to improving the world achieve more than those with a vision to just beat the competition (Logan, King and Fischer-Wright, 2008). There are also links to research on 'socialized visionary communication' (Waldman *et.al.* 2008), and the concept of leaders being more inspiring when they focus people on a social change (Brown and Trevino, 2006).

A numeric scale for measuring engagement

We propose the creation of a numerical scale that can be used to summarize average engagement levels for a project, an individual in their role, or a team or larger organization. This will facilitate more accurate research about the impact of engagement. While further work needs to be done to link these levels to specific biological markers, we propose that this framework will enable more accurate thinking about engagement in the future.

What effect does increasing or decreasing engagement have on the brain and our wider biology?

Engagement involves the central and autonomic nervous system to maintain the internal attention and rewarding states (Csikszentmihalyi, 2008; Posner *et.al.* 2009). We propose that five brain networks are impacted by the threat and reward response and thus by engagement levels. These are:

1. **Cognitive networks:** Lateral PFC and ACC provide the capacity for clear thinking and better executive attention suggesting these have optimal cognitive function during engagement (Posner *et.al.* 2007).
2. **Limbic system:** The reward experience and positive emotion require the involvement of the central and autonomic nervous system, indexed by higher immune function and body coordination. In other words, the central and autonomic nervous system interaction, termed as 'being state' (Tang *et.al.* 2009).
3. **Social network:** In the workplace, collaboration and understanding others are the vital abilities for success and survival, in this regard, MPFC is the core region (Fair *et.al.* 2008).
4. **Self-regulation network:** ACC is responsible for the regulation of both cognition and emotion (Tang and Posner, 2008). Dorsal ACC serves for cognitive regulation and conflict resolution whereas ventral ACC is involved in emotional regulation (Posner *et.al.* 2007). If strong conflict occurs, the PFC may also participate.
5. **Learning and habit circuits:** Positive experience of engagement facilitates and enhances and strengthens working memory (WM). Repeated WM forms long-term memory, then habits via basal ganglia/striatum and PFC, ACC, etc. (Tang, 2009).

In sum, we propose the brain networks including PFC, ACC, mPFC and striatum as the main engagement circuits, and these brain networks are regulated or impacted by various levels of engagement.

Let's explore the states of deep engagement, neutral and disengagement as examples to link the related networks with mental experiences involved in engagement. During the deep engagement state, a person still accomplishes a task or goal with the absence of subjective effort, which might at another time or by another person seem effortful. The person feels totally occupied with the present task so as to suspend evaluations, and has strong pleasure and rewarding feeling, which involves being completely in the current moment.

Actively disengaged	Disengaged	Neutral	Engaged	Deeply engaged
			50	100

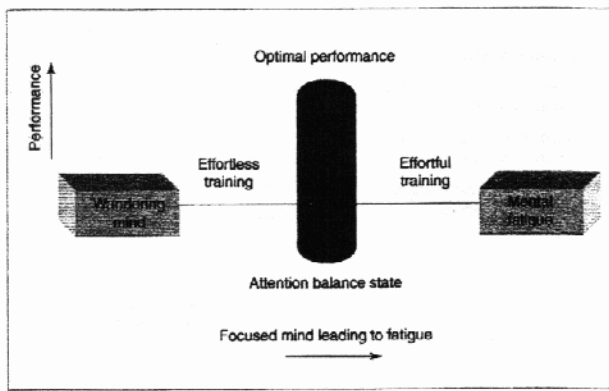


Figure 1: Training and Performance. Mind wandering and mental fatigue are two extremes of the untrained mind (left and right gray rectangles). Attention training requires effortful control to improve performance whereas attention state training changes body-mind state through effortless practice. Optimal balance (attention balance state) is hypothesized to trigger the most efficient performance (middle cylinder area), see Tang and Posner (2009). If the process requires teamwork, mPFC will be involved in to support the group dynamics and collaboration.

Given the effortful control, PFC is dominant in early stage of deep engagement, whereas ACC and striatum take the role with less effort during the mid- or late stage of deep engagement, then the person attains an attention balance state showing optimal performance (Posner *et.al*, 2009; Tang *et.al*, 2009).

During a neutral state, we propose the person is in the default mode of network or brain resting states, involved in the ACC, mPFC and PCC circuit (Raichel *et.al*, 2001). This state maintains the self-referential, introspective mental activity.

In contrast, disengagement includes fear or other negative emotions. This will involve amygdala-related networks. This state occupies large amount brain resources and decreases attentional efficiency. Meanwhile, it activates the autonomic and central nervous system, which triggers the stress response. As a consequence, it will reduce the creativity and productivity, induce mental fatigue (Tang and Posner, 2009) and comes with long-term health problems.

In this threat state people are likely to want to stay doing the same things, as change is harder due to overall less prefrontal resources. Insights are harder (Jung-Beeman *et.al*, 2009), making difficult problems seem insurmountable. It will be harder to stay cool under pressure with a high baseline threat level. Others may be less inclined to collaborate.

Clearly the level of engagement or otherwise of an individual, a team, an organization or even a country can impact performance in tangible ways. The level of engagement or otherwise has a very real impact on one's ability to solve problems, make decisions, stay cool under pressure, collaborate with others and deal with change, all four domains of NeuroLeadership.

...the level of engagement or otherwise of an individual, a team, an organization or even a country can impact performance in tangible ways.

States	Brain networks	Functions
Deep engagement	PFC, ACC, striatum, mPFC	Reward, attention, flow
Neutral	mPFC, ACC, PCC	Self-referential and interoception
Disengagement	Amygdala, limbic system	Negative emotional feelings

What biological markers might be used to more accurately measure engagement, and the effects of engagement interventions?

As mentioned above, engagement involves diverse central and autonomic nervous system including Cognitive networks (lateral PFC), Limbic system (ACC, insula, etc), Social network (mPFC), Self-regulation network (PFC and ACC) and Learning and habit circuits (striatum). To measure the engagement state accurately and test the effects of engagement interventions, we propose the following brain-body biological markers (Tang *et.al*, 2009; Tang and Posner, 2009).

- 1. Brain:** the activations of PFC, ACC, mPFC and striatum using neuroimaging (fMRI, PET, SPECT and EEG, MEG) would be the neural markers to measure and evaluate engagement.
- 2. Physiology (body):** the involvement of the autonomic nervous system indexed by heart rate variability (HRV), and skin conductance response (SCR) would be ideal physiological biomarkers to measure engagement (Tang *et.al*, 2009). To measure the stress level in autonomic system (body) cortisol is one of the best indexes (Tang *et.al*, 2007; 2009).

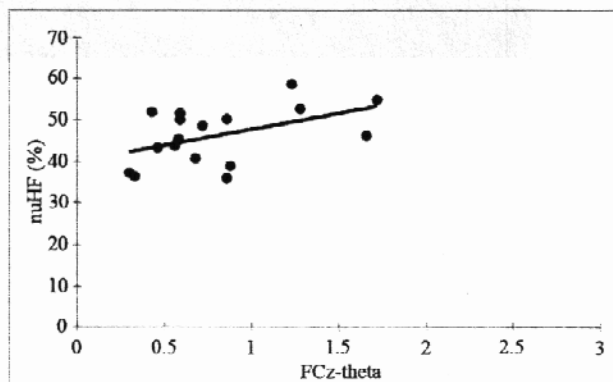


Figure 2: Correlation between High-frequency HRV and FCz-Theta in IBMT following five days of training: The horizontal axis indicates the percent change in frontal midline theta power (in FCz) and the vertical axis indicates percent change in normalized unit of high-frequency (nuHF) HRV. A positive Pearson's correlation was observed ($r=0.551$, $P=0.033$).

3. Brain-body interaction: engagement requires the coordination and balance between body and brain systems. Attention and meditation training literatures indicated the theta band in the brain (self-regulation circuits including ACC, PFC) correlates with HRV (autonomic system), suggesting the optimal state of body and mind-engagement and flow states. This connection between body and brain may provide the inner psych-physiological foundation of engagement (Tang *et.al*, 2009).

In organizations, if you could not use fMRI, you could work with a neuroscientist before and after interventions to test changes in skin conductance response (SCR); one form of simple technique and index to measure the relaxation and calm state of body and mind for employees. You could also use heart rate to analyze the heart rate variability (HRV), another sensitive index for sympathetic and parasympathetic activity during different stages of engagement (Tang *et.al*, 2009). (See Appendix 3)

Summary

In summary, by looking at engagement through the lense of neuroscience, we can develop a deeper understanding of the impact of levels of engagement on human performance, as well as measure engagement levels before and after various interventions. In time, the idea of employee engagement may be able to shift from a 'soft' metric to something with data behind it.

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Appendix 1

The most wide spread research by engagement has been done by Gallup and their 'Q12' assessment. This is comprised of these questions, which Gallup believes are the most central to engagement.

- Do you know what is expected of you at work?
- Do you have the materials and equipment you need to do your work right?
- At work, do you have the opportunity to do what you do best every day?
- In the last seven days, have you received recognition or praise for doing good work?

- Does your supervisor, or someone at work, seem to care about you as a person?
- Is there someone at work who encourages your development?
- At work, do your opinions seem to count?
- Does the mission/purpose of your company make you feel your job is important?
- Are your associates (fellow employees) committed to doing quality work?
- Do you have a best friend at work?
- In the last six months, has someone at work talked to you about your progress?
- In the last year, have you had opportunities at work to learn and grow?

The most wide spread research by engagement has been done by Gallup...

Here is Gallup's survey, put into SCARF categories:

Status - 6

1. In the last seven days, have you received recognition or praise for doing good work?
2. At work, do you have the opportunity to do what you do best every day?
3. Does the mission/purpose of your company make you feel your job is important?
4. In the last six months, has someone at work talked to you about your progress?
5. In the last year, have you had opportunities at work to learn and grow?
6. At work, do your opinions seem to count?

Certainty - 1

1. Do you know what is expected of you at work?

Autonomy - 1

1. Do you have the materials and equipment you need to do your work right?

Relatedness - 2

1. Does your supervisor, or someone at work, seem to care about you as a person?
2. Is there someone at work who encourages your development?

Fairness - 1

1. Are your associates [fellow employees] committed to doing quality work?

Appendix 2

The meta study of 12 other large studies by the Conference Board found eight themes for what seems to create engagement, as follows:

- **Trust and integrity**
How well managers communicate and 'walk the talk'.
- **Nature of the job**
Is it mentally stimulating day-to-day?
- **Line of sight between employee performance and company performance**
Does the employee understand how their work contributes to the company's performance?
- **Career Growth opportunities**
Are there future opportunities for growth?
- **Pride about the company**
How much self-esteem does the employee feel by being associated with their company?
- **Coworkers/team members**
Significantly influence one's level of engagement
- **Employee development**
Is the company making an effort to develop the employee's skills?
- **Relationship with one's manager**
Does the employee value his or her relationship with his or her manager?

Gallup's survey is heavily weighted to status. Look at the Conference Board's study broken into the categories:

Status

1. **Employee development**
Is the company making an effort to develop the employee's skills?
2. **Career Growth opportunities**
Are there future opportunities for growth?
3. **Pride about the company**
How much self-esteem does the employee feel by being associated with their company?

4. Nature of the job

Is it mentally stimulating day-to-day?

Certainty

1. Line of sight between employee performance and company performance

Does the employee understand how their work contributes to the company's performance?

Autonomy

Relatedness

1. Relationship with one's manager

Does the employee value his or her relationship with his or her manager?

2. Coworkers/team members

Significantly influence one's level of engagement

Fairness

1. Trust and integrity

How well managers communicate and 'walk the talk'.

Appendix 3

1. **Skin conductance response (SCR):** SCR is one of the most robust and well studied physiological responses. It is caused by sympathetic nervous system activation, which changes the levels of sweat in the eccrine sweat glands and has been shown to be linked to measures of emotion, arousal, and attention. The lower score of SCR shows more parasympathetic activity with calm and relaxed state.

The lower score of SCR shows more parasympathetic activity with calm and relaxed state.

2. **Heart rate variability (HRV):** HRV is a noninvasive technique that allows for a reliable and accurate measure of sympathetic and parasympathetic functions. Calculated by heart rate, HRV has three frequencies: high frequency (HF; 0.16-0.45 Hz), low frequency (0.04-0.15 Hz), and very low frequency (VLF; 0-0.03 Hz). More HF-HRV indicates relaxed and calm state with parasympathetic activity dominance, which is close to engagement state, whereas more LF-HRV indicates the excited and active state with sympathetic activity dominance.

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