Lead Article

Perspectives and challenges for the study of brain responses to coaching: Enhancing the dialogue between the fields of neuroscience and coaching psychology

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The interest in coaching psychology and neuroscience have been steadily increasing over the past 15 years. However, the two fields have not yet established consistent dialogues underpinned by experimental research. This paper highlights the importance of such dialogue for the growth of evidence-based coaching and how coaching psychology could benefit from previous neuroimaging and electroencephalographic studies in the field of psychotherapy and task-specific brain functioning to design research protocols that could significantly contribute to our understanding of how coaching works at the brain level and how coachees could best achieve results.

Keywords: *coaching psychology; neuroscience; neuropsychology; neurocoaching; cognitive-behavioural coaching; cognitive-behavioural therapy; experimental designs.*

FOR MANY YEARS, psychological knowledge was based solely on clinical/social observation and behavioural testing. Thanks to the current advances in neurobiology, these observations and principles can now be tested experimentally at the brain level with non-invasive neuroimaging and electroencephalographic (EEG) techniques. Indeed, it is now widely accepted that feelings and behaviours are mediated by specific brain networks, and changes in patterns of interaction should be associated with differential cerebral activation (Almeida et al., 2013).

Growing evidence shows that neurons survive upon activation, and the more frequent and intense synaptic transmission occurs between two cells the more likely the circuit they are part of will be strengthened and recruited under similar circumstances (Brown, 1990; Hebb, 1949). This general law is believed to underlie our learning process and mental habits: through intricate genetic and environmental regulation, patterns of activation are delineated in the brain and, essentially, will shape our selves at the synaptic level (LeDoux, 2003). Understanding this simple yet fundamental rule is essential for comprehending key elements for successful coaching outcomes, such as the importance of action through practice to promote change via performance enhancing thinking and other cognitive reappraisal techniques that make coaching such a unique and powerful transformation tool.

Despite this, however, little has been devoted specifically in the coaching psychology field to the evidence-based growth of neurocoaching, that is, the application of neuroscientific knowledge to the understanding and improvement of the coaching process. However, it is worth noting that the publication of a number of books on the application of neuroscience to coaching reflect the growing interest in the field (e.g. Brann, 2014; Brown & Brown, 2012; Rock & Page, 2009).

This brief theoretical paper aims at highlighting the desire of researchers to bridge the gap between coaching psychology and neuroscience, pointing out some of the technical challenges involved in this endeavour and the possible experimental designs that might contribute to our understanding of how coaching modifies the brain to promote personal change and well-being.

Coaching psychology and neuroscience: Inspiration from cognitive-behavioural therapy studies

Neuroimaging has been widely used to investigate not only the neurobiological changes evoked by cognitive-behavioural therapy (CBT) but also the neural correlates of specific psychiatric conditions (Table 1; Figure 1). In this context, it has been reported that patients suffering from post-traumatic stress disorder (PTSD) who present poor therapeutic improvement exhibit greater activation of the amygdala and ventral anterior cingulate when presented to masked fearful faces (Bryant et al., 2008), pointing for these structures to comprise the network involved with fear-related responses in this disorder. In patients with spider phobia treated with CBT, a significant decrease of prefrontal and parahippocampal activation was identified by functional magnetic resonance imaging (fMRI) during the paradigm of symptom provocation – that is, when patients were presented to images (in this case, to film excerpts) of the phobic stimulus (Paquette, Levesque & Mensour, 2003). The authors interpreted that the absence of activation of these neural correlates would reflect the successful fear extinction process triggered by CBT. According to Porto et al. (2008), this process of extinction would, then, contribute to prevent the reactivation of aversive, traumatic memories, allowing individuals to modify their perception of the stimulus. Considering that, although not in the context of traumas or dysfunctional fear, cognitive-behavioural coaching (CBC) works towards helping coachees to perceive and cope with challenging stimuli it could be hypothesised that adapting these neuroimaging techniques to the coaching context could result in a better understanding of how the coaching process can change perceptions and behaviour via changing the brain.

CBT has also been shown to alter brain connectivity in panic disorder (PD) (Carvalho et al., 2010). Curiously, pre-post treatment differences have been recently identified in the connectivity between the inferior frontal gyrus and the so-called fear network during fear conditioning (Kircher et al., 2013). In a study with social anxiety disorder (SAD) patients undergoing CBT, Goldin et al. (2013) used an interesting experimental design during fMRI scanning: negative self-beliefs embedded in autobiographical social situations were mentally read by patients who should either react or reappraise these cognitions, so that the brain areas rewired by the CBT induced-learning could be unraveled. Other studies used brain imaging to explore the neural structures underlying other types of learning/memory, which are not emotionally-related (Toepper et al., 2010a, 2010b). These studies are particularly interesting in the context of identifying key brain areas mediating learning: coaching psychology studies could be inspired by this kind of paradigm, by investigating the brain responses of coachees to certain learning tasks. In other words, this kind of experimental paradigm would make it possible to understand how the coaching process facilitates learning at the brain level.

Although the aforementioned studies do not correspond to the majority of studies in the field and much is yet to be investigated, neuroimaging and EEG techniques have been greatly contributing to our current understanding of how the human brain works in the context of certain psychiatric conditions and under specific stimulation. However, despite the growth of coaching and coaching psychology, there are no studies so far conducted in order to establish the neural correlates of coaching efficacy. The question 'How does coaching work?' remains, essentially, unanswered. In order to fully answer this, another question needs to be approached: How does coaching rewire the brain?

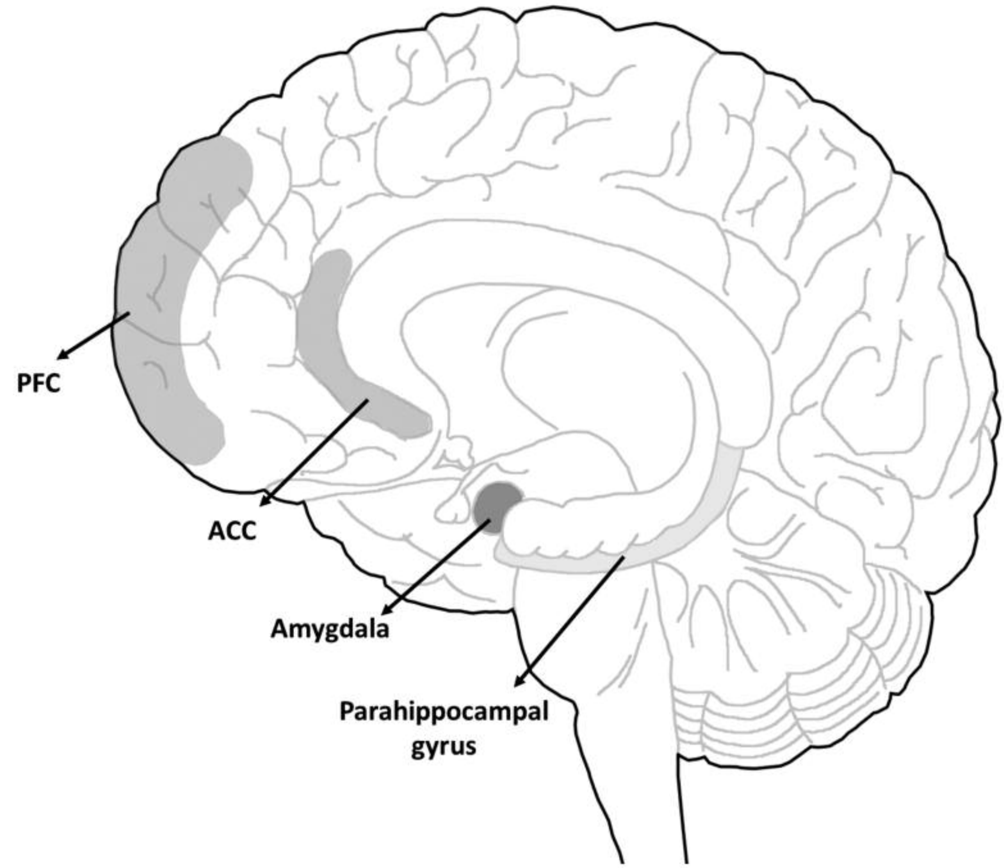
The application of neuroimaging techniques to the coaching context could not only contribute to the development and optimisation of coaching techniques that could be considered more effective for enhancing certain identified brain areas, but could also become a tool to predict coaching effectiveness to a given individual. The proposal to use neuroimaging as a means to identify biomarkers capable of predicting the success of a proposed intervention is something already taking place for treatment choice for depression. For instance, in a recent study using positron emission tomography (PET), brain activity in the right anterior insula prior to treatment predicted whether patients with depression would best respond to antidepressant or CBT (McGrath et al., 2013). The search for this type of approach is of great value, considering that it can help move intervention outcome beyond trial-and-error to more personalised actions (Niciu et al., 2014). Although coaching is known to be highly effective, future descriptions of which set of techniques or approach could be more helpful to a given coachee based on their brain patterns can be an invaluable resource to save time and costs and enhance results.

Table 1: Neuroimaging protocols from CBT or pharmacological studies.

Study	Psychiatric condition	Neuroimaging technique	Experimental protocol: imaging stimulus
Paquette et al., 2003	Specific phobia	fMRI	Symptom provocation (phobogenic image/video)
Ritchey et al., 2011	Major depression disorder	fMRI	Positive, negative, and neutral pictures
Lemogne et al., 2010	Major depression disorder	fMRI	Visually presented words representing personality traits
Goldin et al., 2013	Social anxiety disorder	fMRI	Reaction to and cognitive reappraisal of negative self-beliefs inserted in autobiographical social anxiety situations
Klumpp et al., 2013	Social anxiety disorder	fMRI	Social signals of threat (fearful/angry faces)
Doehrmann et al., 2013	Social anxiety disorder	fMRI	Social signals of threat (angry faces x neutral faces)
Kircher et al., 2013	Panic disorder with agoraphobia	fMRI	Fear conditioning

All studies performed the imaging before and after the proposed intervention. These examples could be inspirational for future controlled studies in the neurocoaching field. CBT=cognitive-behavioural therapy; fMRI=functional magnetic resonance imaging.

Figure 1: Schematic illustration of some of the brain areas differentially activated in response to CBT.



Neuroimaging studies have shown that, at the brain level, CBT exerts its effects by modifying neural activation in areas such as the ACC, the parahippocampal gyrus, the amygdala and the PFC. Would CBC result in differential activation of similar areas in similar ways? Questions like this are starting to be posed by coaching psychologists aiming to investigate the neural substrates of coaching effectiveness. ACC=anterior cingulate cortex; CBC=cognitive-behavioural coaching; CBT= cognitive-behavioural therapy; PFC=prefrontal cortex. Illustration by co-author Bevilaqua, M.C.N.

Coaching psychology and neuroscience: Challenges

One of the challenges for the study of brain responses to coaching is in fact a challenge not restricted to the coaching research but to any interventional programme: neuroimaging and EEG readings cannot be made during speech or neck/head/face movement from the participant due to generation of artefacts, strong interfering signals that can act as confounders of the actual neural transmission underlying the mental functions studied. This means that, unfortunately (and as occurs for psychotherapy studies), it is not yet possible to scan a coachee's brain during a typical coaching session. Such an approach, made possible in the future, could enable the key brain areas mediating change in a given approach to be identified real-time so that a better understanding of how different coaching schools deliver results can be built, and for approaches to be compared at the brain level.

Another challenge for the study of brain responses to coaching is imposed by the coaching population itself. Neuroimaging findings are greatly based on abnormal brain functioning, in that the identification of differential signals between healthy x disordered brains is much facilitated. Coaching clients, on the other hand, might have overall baseline brain functioning very similar to healthy controls not receiving coaching interventions. For instance, it is very common that neuroimaging studies use as stimuli the positive, neutral and negative pictures (Ritchey et al., 2011) from the International Affective Picture System (IAPS) picture database (Lang, Bradley & Cuthbert, 2001) or fearful/angry (Klumpp, Fitzgerald & Phan, 2013)/angry x neutral faces (Doehrmann et al., 2013) from standardised databases of emotional expressions (Gur et al., 2002; Tottenham et al., 2009). It is possible that, given the subclinical population of coaching, no differential activation pre-post CBC intervention to such kind of stimuli will be observed. However, if coaching exerts significant cognitive, emotional and behavioural effects, it changes brain connectivity somehow and identifying how and where in the brain these changes are made might be a matter of more sensitive and powerful neuroimaging techniques to evolve.

On the other hand, not every neuroimaging study compares controls to psychiatric patients. In this way, hope for experimental designs that could be applied in the short term (that is, with the currently available neural readings techniques) with the coaching population emerges from studies aiming at unravelling brain functioning during specific tasks that are not related to neuropsychiatric symptoms.

Coaching psychology and neuroscience: Perspectives

There are a number of interesting questions posed by coaching psychologists that neuroscience could help answer in order to depict how the coached brain works. In this context, it is already known that coaching improves or enhances goal-striving, well-being, hope, resilience, quality of life and work performance (e.g. Grant, Curtayne & Burton, 2009; Green, Oades & Grant, 2006) but would there be associated effects to specific executive functions, such as attention, memory, problem-solving and creative thinking? And by which means does coaching decrease performance anxiety?

For this latter question, experimental designs inspired by those described for SAD could be of special relevance. The assessment of the other aforementioned brain functions would, however, require inspiration from neuropsychology and cognitive psychology studies.

In this sense, it could be highlighted the Corsi block tapping test (Corsi, 1973), a task developed to assess spatial working memory that involves tapping a certain sequence of blocks after observation of the sequence tapped by the researcher, and which is possible to be performed during brain scanning (Nemmi et al., 2013; Toepper et al., 2010a, 2010b). As for the study of creative thinking as a positive consequence of the coaching process, the Alternate Uses Task (Guilford, 1967) could be an appropriate choice. In this test, the individual is shown an everyday object (such as a brick or pencil) and, in a given time, should be able to come up with as many uses for it as possible. Variants of this task have been successfully used in EEG studies as reviewed by Arden et al. (2010).

Another possibility could be the use of words as stimuli. In this context, a previous study used specific terms describing personality traits in order to assess brain areas involved in self-referential processing (Lemogne et al., 2010). Although this was a pilot study with depressed patients, this kind of stimulus could be useful in neurocoaching experimental designs willing to unravel differential activation of brain areas underlying perfectionist trends, and other self-referential related beliefs; performance blocking x performance enhancing cognitive patterns, as well as problem-solving skills. Word-association tasks as a tool to investigate creativity are also possible during brain imaging (Andreasen & Ramchandran, 2012). As a whole, virtually any kind of cognitive task that involves either thinking or button-pressing as the means to deliver the response to the stimulus presented can be used during scanning of the coachee's brain.

In addition, previous studies showed changes in hormonal levels such as those of the stress hormone cortisol and noradrenaline (e.g. Manyande et al., 1995; Rockcliff et al., 2008), alpha amylase (Duarte et al., 2014) and in heart rate variability (Rockcliff et al., 2008) following imagery techniques that can be used by therapists and coaches working on reducing self-criticism and increasing compassion (e.g. Palmer, 2009), as well as enhancing resilience and coping (e.g. Palmer, 2013). Such an approach highlights the possibility of future neurocoaching investigations to embrace other physiological measures that not only those directly related to brain responses. Combining brain functioning data with biomarkers levels may provide researchers and practitioners with a more complete overview of the biological basis through which the coaching process may exert its effects.

Interestingly, these perspectives hold the ability to open new avenues in the study and validation of coaching approaches: by making it possible to compare how different schools might deliver results via enhancing specific brain functions and leading to differential changes in the levels of associated biomarkers, relevant information on the nature of each coaching approach may emerge. Consequently, multimodal techniques could be, at the brain level, shown to be more effective to improve a wider range of skills.

Conclusion

In the same way that psychotherapy needs to be underpinned by a thorough investigation of its underlying neurobiological correlates for the improvement of therapeutic interventions (Linden, 2006), it seems essential that coaching psychology includes in its agenda the study of the neural basis of coaching efficacy. Perhaps the full establishment of coaching psychology as an evidence-based approach greatly depends on its effort to unravel how coaching psychology practice modifies the brain. In this sense, future studies aiming at investigating the neurobiological basis of coaching – including neuroimaging and EEG techniques, as well as biochemical assays in order to identify biomarkers to predict outcome and help measure efficacy – are not only encouraged but are also a need for coaching psychology to fully conquer its well-deserved scientific status.

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For further information on the functional anatomy of the human brain, please visit: http://www.innerbody.com/image/nerv02.html

References

Almeida, A., Filho, G.M.A., Berberian, A.A., Trezsniak, C., Fernandes, F.N., Neto, C.A.A., Jackowski, A.P., Scippa, A.M. & Oliveira, I.R. (2013). The impacts of cognitive-behavioral therapy on the treatment of phobic disorders measured by functional neuroimaging techniques: A systematic review. *Revista Brasileira de Psiquiatria, 35*(3), 279–283.

Andreasen, N.C. & Ramchandran, K. (2012). Creativity in art and science: Are there two cultures? *Dialogues in Clinical Neuroscience, 14*(1), 49–54.

Arden, R., Chavez, R.S., Grazioplene, R. & Jung, R.E. (2010). Neuroimaging creativity: A psychometric view. *Behavioural Brain Research, 214*(2), 143–156.

Brann, A. (2014). *Neuroscience for coaches: How to use the latest insights for the benefit of your clients paperback.* London: Kogan Page.

Brown, P. & Brown, V. (2012). *Neuropsychology for coaches: Understanding the basics.* Maidenhead: Open University Press.

Brown, T.H., Kairiss, E.W. & Keenan, C.L. (1990). Hebbian synapses: Biophysical mechanisms and algorithms. *Annual Review of Neuroscience, 13*, 475–511.

Bryant, R.A., Felmingham, K., Kemp, A., Das, P., Hughes, G., Peduto, A. & Williams, L. (2008). Amygdala and ventral anterior cingulate activation predicts treatment response to cognitive behaviour therapy for post-traumatic stress disorder. *Psychological Medicine, 38*(4), 555–561.

Carvalho, M.R., Dias, G.P., Cosci, F., Neto, V.L.M., Bevilaqua, M.C., Gardino, P.F. & Nardi, A.E. (2010). Current findings of fMRI in panic disorder: Contributions for the fear neurocircuitry and CBT effects. *Expert Review of Neurotherapeutics, 10*(2), 291–303.

Corsi, P.M. (1973). Human memory and the medial temporal region of the brain. *Dissertation Abstracts International, 34*(2), 891B.

Doehrmann, O., Ghosh, S.S., Polli, F.E., Reynolds, G.O., Horn, F., Keshavan, A., Triantafyllou, C., Saygin, Z.M., Whitfield-Gabrieli, S., Hofmann, S.G., Pollack, M. & Gabrieli, J.D. (2013). Predicting treatment response in social anxiety disorder from functional magnetic resonance imaging. *JAMA Psychiatry, 70*(1), 87–97.

Duarte, J., McEwan, K., Barnes, C., Gilbert, P. & Maratos, F.A. (2014). Do therapeutic imagery practices affect physiological and emotional indicators of threat in high self-critics? *Psychology and Psychotherapy: Theory, Research and Practice.* doi: 10.1111/papt.12043

Goldin, P.R., Ziv, M., Jazaieri, H., Hahn, K., Heimberg, R. & Gross, J.J. (2013). Impact of cognitive behavioural therapy for social anxiety disorder on the neural dynamics of cognitive reappraisal of negative self-beliefs: Randomised clinical trial. *JAMA Psychiatry, 70*(10), 1048–1056.

Grant, A.M., Curtayne, L. & Burton, G. (2009). Executive coaching enhances goal attainment, resilience and workplace well-being: A randomised controlled study. *Journal of Positive Psychology, 4*(5), 396–407.

Green, L.S., Oades, L.G. & Grant, A.M. (2006). Cognitive-behavioural, solution-focused life coaching: Enhancing goal striving, well-being and hope. *Journal of Positive Psychology, 1*(3), 142–149.

Guilford, J.P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Gur, R.C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., Turner, T., Bajcsy, R., Posner, A. & Gur, R.E. (2002). A method for obtaining three-dimensional facial expressions and its standardisation for use in neurocognitive studies. *Journal of Neuroscience Methods, 115*(2), 137–143.

Hebb, D.O. (1949). *The organisation of behaviour.* New York: John Wiley.

Kircher, T., Arolt, V., Jansen, A., Pyka, M., Reinhardt, I., Kellermann, T., Konrad, C., Lueken, U., Gloster, A.T., Gerlach, A.L., Ströhle, A., Wittmann, A., Pfleiderer, B., Wittchen, H.U. & Straube, B. (2013). Effect of cognitive-behavioural therapy on neural correlates of fear conditioning in panic disorder. *Biological Psychiatry, 73*(1), 93–101.

Klumpp, H., Fitzgerald, D.A. & Phan, K.L. (2013). Neural predictors and mechanisms of cognitive behavioral therapy on threat processing in social anxiety disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 45*, 83–91.

Lang, P.J., Bradley, M.M. & Cuthbert, B.N. (2001). *International affective picture system (IAPS): Instruction manual and affective ratings. Technical report A-5.* Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

LeDoux, J. (2003). *Synaptic self: How our brains become who we are.* New York: Penguin Books.

Lemogne, C., Mayberg, H., Bergouignan, L., Volle, E., Delaveau, P., Lehéricy, S., Allilaire, J.F. & Fossati, P. (2010). Self-referential processing and the prefrontal cortex over the course of depression: A pilot study. *Journal of Affective Disorders, 124*(1–2), 196–201.

Linden, D.E. (2006). How psychotherapy changes the brain – the contribution of functional neuroimaging. *Molecular Psychiatry, 11*(6), 528–538.

Manyande, A., Berg, S., Gettins, D., Stanford, S.C., Mazhero, S., Marks, D.F. & Salmon, P. (1995). Pre-operative rehearsal of active coping imagery influences subjective and hormonal responses to abdominal surgery. *Psychosomatic Medicine, 57*, 177–182.

McGrath, C.L., Kelley, M.E., Holtzheimer, P.E., Dunlop, B.W., Craighead, W.E., Franco, A.R., Craddock, R.C. & Mayberg, H.S. (2013). Toward a neuroimaging treatment selection biomarker for major depressive disorder. *JAMA Psychiatry, 70*(8), 821–829.

Nemmi, F., Boccia, M., Piccardi, L., Galati, G. & Guariglia, C. (2013). Segregation of neural circuits involved in spatial learning in reaching and navigational space. *Neuropsychologia, 51*(8), 1561–1570.

Niciu, M.J., Mathews, D.C., Nugent, A.C., Ionescu, D.F., Furey, M.L., Richards, E.M., Machado-Vieira, R. & Zarate, C.A. Jr. (2014). Developing biomarkers in mood disorders research through the use of rapid-acting antidepressants. *Depression and Anxiety, 31*(4), 297–307.

Palmer, S. (2009). Compassion-focused imagery for use within compassion focused coaching. *Coaching Psychology International, 2*(2), 13.

Palmer, S. (2013). Resilience enhancing imagery: A cognitive behavioural technique which includes resilience undermining thinking and resilience enhancing thinking. *The Coaching Psychologist, 9*(1), 48–50.

Paquette, V., Levesque, J. & Mensour, B. (2003). Change the mind and you change the brain: Effects of cognitive behaviour therapy on the neural correlates of spider phobia. *Neuroimage, 18*, 401–409.

Porto, P.R., Oliveira, L., Mari, J., Volchan, E., Figueira, I. & Ventura, P. (2009). Does cognitive behavioural therapy change the brain? A systematic review of neuroimaging in anxiety disorders. *The Journal of Neuropsychiatry & Clinical Neurosciences, 21*(2), 114–125.

Ritchey, M., Dolcos, F., Eddington, K.M., Strauman, T. J. & Cabeza, R. (2011). Neural correlates of emotional processing in depression: Changes with cognitive behavioural therapy and predictors of treatment response. *Journal of Psychiatric Research, 45*(5), 577–587.

Rock, D. & Page, L.J. (2009). *Coaching with the brain in mind: Foundations for practice.* Chichester: John Wiley & Sons.

Rockcliff, H., Gilbert, P., McEwan, K., Lightman, S. & Glover, D. (2008). A pilot exploration of heart rate variability and salivary cortisol responses to compassion-focused imagery. *Clinical Neuropsychiatry, 5*(3), 132–139.

Toepper, M., Gebhardt, H., Beblo, T., Thomas, C., Driessen, M., Bischoff, M., Blecker, C.R., Vaitl, D. & Sammer, G. (2010a). Functional correlates of distractor suppression during spatial working memory encoding. *Neuroscience, 165*(4), 1244–1253.

Toepper, M., Markowitsch, H.J., Gebhardt, H., Beblo, T., Thomas, C., Gallhofer, B., Driessen, M. & Sammer, G. (2010b). Hippocampal involvement in working memory encoding of changing locations: An fMRI study. *Brain Research, 1354*, 91–99.

Tottenham, N., Tanaka, J.W., Leon, A.C., McCarry, T., Nurse, M., Hare, T.A., Marcus, D.J., Westerlund, A., Casey, B.J. & Nelson, C. (2009). The NimStim set of facial expressions: Judgements from untrained research participants. *Psychiatry Research, 168*(3), 242–249.