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Motivational Interviewing and Neuroscience: Moving forward while looking deeper

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Psychosocial interventions have been comparatively effective at promoting behavioural changes through addressing maladaptive cognitions and affects. (Clark & Beck, 2010; DiClemente, Nidecker, & Bellack, 2008; Straube, Glauer, Dilger, Mentzel, & Miltner, 2006; Strauss, Cavanagh, Oliver, & Pettman, 2014; Teasdale et al., 2000; Tevyaw & Monti, 2004). While the main research focus still remains on how to effect changes and links between cognition affect and behaviour, there is increasing interest in understanding how changes are made at a neurobiological level. With increased emphasis on cross disciplinary intervention and research the potential linkage between brain topological measures with cognitive and behaviours changes is particularly compelling. Firstly, it 'connects' cognitive and behaviour changes to putative neural mechanisms hence providing an avenue towards understanding how psychosocial interventions work (Feldstein Ewing, Filbey, Sabbineni, Chandler, & Hutchison, 2011). Secondly, it may serve as a potential promising tool for monitoring of treatment effects through examining whether treatment in question demonstrates an alteration or shift of brain state that resembled that of healthy counterparts (Etkin, Pittenger, Polan, & Kandel, 2005). Thirdly, Sensitivity of neuroimaging allows categorization of individuals with distinct etiologies previously indistinguishable through clinical variables. Independent examinations of these subgroups provide critical information regarding applicability of particular treatments, allowing further refinement of treatments (Etkin et al., 2005; Linden, 2006).

There is evidence of adaptive brain functional changes in response to exposure/participation in psychosocial interventions. For instance, the brain regions (namely dorsolateral prefrontal cortex and parahippocampal gyrus, of individuals) that are typically activated during state of fear, were no longer activated after Cognitive Behaviour Therapy (CBT) based intervention. These study findings suggest a deconditioning of brain response through decreasing disruptive and misattributing thinking at the level prefrontal cortex and parahippocampal (Paquette et al., 2003). Likewise, other studies revealed a decrease of activity in brain regions specifically the amygdala of limbic system and cingulate cortex in individuals with depression, further implying a shift from abnormality to normality patterns after treatment [for review see Collerton (2013)]. In general, the potential of psychological interventions to alter the brain function may 'rewire' the dysfunctional brain circuitry associated with disruptive behaviours and symptoms (Gorman, Kent, Sullivan, & Coplan, 2000; Paquette et al., 2003). While aforementioned studies illustrated an enormous lead towards unravelling how effects of psychosocial interventions can be transduced at neurobiology level, there is nonetheless relatively limited work on the neurobiological processes of Motivation Interview (MI).

MI is a counselling approach that is person

centered, collaborative and focused on eliciting and strengthening a client's motivation to change (Miller & Rollnick, 2013). Studied extensively since the early 1990s, MI has demonstrated efficacy with behaviours ranging from substance use (Lundahl, Kunz, Brownell, Tollefson, & Burke, 2010) to promoting health behaviour(Martins & McNeil, 2009). Despite its effectiveness, measurable constructs, well-defined theoretical mediators and models (Feldstein Ewing et al., 2011; Houck, Moyers, & Tesche, 2013), there is limited work on the neurocognitive processes that may underpin the observed effects. With recently published work on proof of concept in relation to neurobiology and, this line of research should gain momentum (Potenza et al., 2013).

The handful of studies to date that attempted to map MI processes to brain activity using fMRI have focused on change talk predominantly because change talk is key element in MI [see Resnicow, Gobat, & Naar (2015) in this issue, for a review on key Change Talk strategies]. Houck et al. (2013) has examined the neural circuity underlying change talk. Participants who listened to their own change talk as compared to 'sustain' talk showed significant activation in inferior frontal gyrus, insula and superior temporal cortex. These regions were previously found to be involved in self-perception, cognitive dissonance and attitude change. Feldstein and colleagues (2011) work on the other hand suggests that MI may operate thorough the dampening of reward/motivational circuitry. When adults with alcohol dependence were in change talk condition there was no activation in their reward processing area (OFC, nucleus accumbens, insula, caudate, putamen, PCC and ACC) upon presented with alcohol cue, thus suggesting that change talk might inhibit these regions. Despite that both studies focused on alcohol usage and change talk, there is some variation in their findings in that regions such as insula appeared to be activated in Houck et al's (2013) study while inactivated in Feldstein et al.(2011)'s study. Methodological differences may account for the inconsistent results. Different imaging methods such as haemodynamic imaging (in this instance the fMRI) and neurophysiological imaging (MEG) were used. Moreover, presence of cues used to elicit addictive responses and time of scanning (before, during or after treatment) may also contribute to different results.

Both studies however highlight the neurobiological pathways related to effectiveness of MI intervention in field of addiction and clearly path the way for future cross disciplinary investigations. One of the key directions that may be worth exploring related to connectivity of regions. Traditionally, neuroimaging studies focus on localization of brain functions and identifying brain regions that are activated selectively during the tasks (Chan, Cheung, Ho, & Jing He, 2000). However the architecture of the human brain is organised in terms of several modular neural networks (Fox et al., 2005), suggesting that neural processing involves an integration of distinct brain regions. Of note, it is also important to acknowledge that regions identified do not belong mutually exclusive to a particular network as it could also play a role in another network i.e. orbitofrontal in both motivation and rewards processing networks. Thus, in looking at how change talk may alter the functions of brain, proposed models for future research should also examine functional connectivity within and between multiple networks to allow better understanding of activation patterns and brain functional organization. These may include but not limited to the rewards networks (regions commonly include nucleus accumbens, amygdala, orbitofrontal cortex and the insula), motivation network (orbitofrontal cortex and subcallosal cortex), executive control (mostly located at prefrontal cortex and the anterior cingulate

cortex) as well as memory and learning (hippocampus, amygdala and Precuneus) (Collerton, 2013; Feldstein Ewing et al., 2011; Robbins, Ersche, & Everitt, 2008; Volkow, Fowler, & Wang, 2003).

While examining the connectivity within and between networks shed light into the architecture of human brain functional connectivity and the interplay of regions involved, study could also look at the hierarchical representations of brain regions within and between the networks. Such analysis involves effective connectivity where casual relationships among regions are investigated (Deshpande & Hu, 2012). In another words, casual influences of a particular brain region on another regions can be examined. With this complementary information on top of the aforementioned functional connectivity, regions that play a crucial role in influencing other regions within and between networks can be identified as key neurobiological markers targeted for behaviour change.

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