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Rorschach Nomological Network and Resting-State Large Scale Brain Networks

Introducing a New Research Design

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Abstract: Despite advances in neuroscience, the field of personality assessment has not yet taken full advantage of the progress in neuroimaging techniques. Functional Magnetic Resonance Imaging (fMRI) is one of the most widely used neuroimaging techniques and allows the detection of brain processes and their anatomically detailed correspondences. In the last fifteen years, few studies have developed research designs using the Rorschach test in fMRI settings, analyzing the relationship between Rorschach variables and brain neural circuits. Although their findings were promising, some methodological issues related to fMRI research design have been outlined. Recently, personality neuroscience is emerging as a new field of research that attempts to deepen and refine neurobiological and psychological theories of personality using fMRI in resting state conditions. Recent studies report that resting state networks show a direct relationship with psychological traits. The aim of the present article is to propose a new research design that employs resting-state functional connectivity analyses to explore the brain's functional architecture in relation to psychological constructs of Rorschach variables related to perceptual styles and personality traits.

Keywords: fMRI, nomological networks, resting state, Rorschach

The nomological network (Cronbach & Meehl, 1955) is a system of laws that relate theoretical constructs to observable data, observable data to each other, and theoretical constructs to each other. This network is necessary for providing a conceptualization of psychological constructs and for highlighting that only a network of meaningful associations between theoretical constructs and observable data may determine the validity of a single variable. For the Rorschach, construct validity concerns the parallel between the construct of interest as measured by Rorschach variables and behaviors and processes involved in the production of coded responses (Bornstein, 2012; Mihura, Meyer, Dimitrascu, & Bombel, 2013). For example, according to the Rorschach literature, human movement (M) responses are a measure of the respondent's mental abilities, such as empathy, planning,

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and imagination, because of the implied ability to identify with a human being (Exner, 2003; Exner & Erdberg, 2005; Meyer, Viglione, Mihura, Erard, & Erdberg, 2011; Mihura et al., 2013). Thus, construct validation of M responses should be sustained by the relationship between this Rorschach variable and the construct of empathy. Given the weak relationship between most Rorschach scores and introspective self-reports, recent studies have linked Rorschach variables to findings from the field of cognitive neuroscience. By conducting an EEG study, Giromini, Porcelli, Viglione, Parolin, and Pineda (2010) have shown that EEG mu suppression, a proxy biomarker for mirror neuron activation, occurred concomitantly with the participants attributing human movement to the Rorschach stimuli. Using repetitive transcranial magnetic stimulation (rTMS), a recent study (Ando et al., 2015) has shown that temporary disruption of activity in the left inferior frontal gyrus, which is thought to include a large amount of mirror neurons, yielded a statistically significant reduction in the attribution of human movement to the Rorschach cards. These studies demonstrate that neuroimaging and brain stimulation techniques may be employed to investigate construct validity of Rorschach variables.

Functional Magnetic Resonance Imaging (fMRI) is one of the most widely used neuroimaging techniques (Hamilton, Chen, Thomason, Schwartz, & Gotlib, 2011; de Ruiter, Veltman, Phaf, & van Dyck, 2007; Seminowicz et al., 2004; Walter, Berger, & Schnell, 2009). This technique relies on blood flow and blood oxygenation changes (i.e., Blood-Oxygen-Level Dependent [BOLD] signals) occurring in the brain over time, which are closely related to neural activity. Thus, fMRI techniques allow the detection of brain processes and their anatomically detailed correspondences. fMRI studies have been conducted in different experimental fields and, more recently, they have been used to investigate neural correlates of personality structure, measured by psychological tests, within more complex clinical contexts.

The aim of the present paper was to explore and review the literature related to the Rorschach and fMRI in order to introduce a new research design to investigate the construct validity of the Rorschach. The increasing use of neuroimaging techniques, in particular fMRI, has introduced a revolution in terms of research design, since the activation of specific brain areas can be mapped while subjects are performing cognitive tasks (Van Horn & Ishai, 2007). Thus, neuroimaging techniques may be used in a multidisciplinary perspective and may contribute to the study of the neurophysiological substrates of psychological variables associated with the Rorschach. We reviewed the most important findings related to studies in which the Rorschach was administered in a fMRI setting and focused on different issues emerging from the methodology used by the authors.

Rorschach and fMRI Studies

In the last fifteen years, two research groups have developed research designs using the Rorschach in fMRI settings. Kircher and colleagues (Kircher, Brammer, Williams, & McGuire, 2000; Kircher, Liddle, Brammer, Williams, Murray, & McGuire, 2001; Kircher, Liddle, Brammer, Williams, Murray, & McGuire, 2002; Kircher, Brammer, & McGuire, 2005) presented seven Rorschach cards on a screen during fMRI scanning to elicit fluent speech in patients with schizophrenia and in healthy participants. They correlated different components of fluent speech production (e.g., thought-disordered speech, lexical retrieval and articulation, syntax processing) to BOLD signal changes and, thus, investigated the neural correlates of the process of language generation. The authors demonstrated that patients with schizophrenia showed different patterns of brain activation and produced a lesser rate of complex sentences and more thought-disordered speech compared to healthy participants. Despite the fact that the studies mentioned above represent an innovative use of the Rorschach in fMRI settings, the authors did not examine the relationship between Rorschach variables and patterns of brain activation.

More recently, Asari and colleagues (2008, 2010a, 2010b) investigated the interaction between emotion- and perception-related neural circuits during the administration of the Rorschach. The Japanese research group hypothesized that unique responses on the Rorschach were generated by the interference of emotions during perceptive and projective processing (Exner, 2003). Sixty-eight healthy subjects were exposed to the Rorschach during fMRI scanning and were instructed to say what the inkblot looked like. The authors then classified the Rorschach responses as “frequent,” “infrequent,” or “unique” (Form Quality minus, or FQ-), based on the frequency rate of each response in a matched control group. According to Exner, they adopted a frequency criterion of 2% to classify “frequent” (above the criterion) and “infrequent” (below the criterion) responses, whereas “unique” responses were those that did not occur in the control group. The studies reported by Asari et al. are closely linked together, with each study being based on the findings of the previous one.

The first study (Asari et al., 2008) focused on the neural substrates that underlie unique responses on the Rorschach. Results revealed that unique responses were associated with the activation of the right temporal pole, which is anatomically proximal to limbic structures (e.g., the amygdala). In a recent review (Olson, Plotzker, & Ezzyat, 2007), the temporal pole has been considered as a paralimbic region and is related to the social and emotional processing of sensory stimuli, to the storage of perception–emotion linkages, and to personal semantic memory. Given the link found by the authors between unique (FQ-) responses, temporal pole functions, and the anatomically proximal amygdala, Asari and colleagues hypothesized that unique perception on the Rorschach may be produced by the integration of emotional and perceptual processes.

In the second study (Asari et al., 2010a), based on the anatomical proximity of the amygdala to the temporal lobe and in accordance with the literature, they tested the hypothesis that amygdala volume was related to the production of unique responses on the Rorschach. They found a positive correlation between the unique response ratio (URR; i.e., the number of unique responses divided by the total number of responses), c volume, and other components of the limbic system (e.g., cingulate gyri, which is involved in emotional processing). Thus, results seemed to indicate that emotion-related neural circuits (in particular the limbic system) might underlie the frequent production of unique perception and FQ- responses to the inkblot stimuli. In the third and last study (Asari et al., 2010b), and based on previous results, Asari et al. investigated whether the amygdala was involved in the modulation of the cortical network while participants were involved in the task of finding suitable representations to the inkblot stimuli. The Rorschach variable WSumC (i.e., the weighted sum of responses determined by color) was used as a score for emotional sensitivity. A positive correlation between the URR and WSumC was found, indicating that emotion may play a role in the perception of unique and uncommon percepts on the Rorschach. Moreover, results revealed a significant modulatory effect of the amygdala on the temporopolar region, confirming the interference of emotion on perception during the Rorschach task.

Despite the fact that the abovementioned findings were promising, some methodological issues related to fMRI research design deserve mentioning. The main limitation of using fMRI techniques has to do with the numerous artefacts generated, which can lead to errors in analyzing the results. Firstly, significant scanner noise may undermine the ecological validity of the performance of the subject. For example, subjects may not be able to hear themselves speak clearly. However, Kircher et al. (2005) reported that all participants were able to hear themselves speak in spite of the noise. Secondly, the principal issue related to overt speech responses during fMRI scan concerns artefacts associated with head motion and air volume changes in the sinus cavities and in the pharynx during phonation. The head-motion correction during fluent speech has recently become a real matter of debate because it has been shown that inadequate correction for these artefacts can result in spurious correlations in many fMRI analyses (Lee & Therriault, 2013). Thus, researchers need to quantify and control for head movements to manage this methodological issue. Thirdly, the method of defining the neural regions of interest (ROI) has been reported by Asari et al (2010b) as a methodological concern. The ROI is a subset of an image or a dataset of cerebral regions identified to test a particular hypothesis. Previous neuroimaging studies investigating personality that have used an a priori selection of ROI (Adelstein et al., 2011; Canli, Amin, Haas, Omura, & Constable, 2004; DeYoung, 2010; Eisenberger, Lieberman, & Satpute, 2005; Kumari et al., 2007; Wright et al., 2006) identified this condition as a methodological limitation considering the complexity of the construct investigated: personality traits. Given that personality traits are associated with extended distributed networks of regions, rather than being localized in a few specific regions, dynamic interactions of large-scale networks, including low-level sensory and high-order cognitive brain regions, form the basis of complex thought and behavior (Adelstein et al., 2011). Thus, the inclusion of large-scale data-driven methods is necessary to investigate the neural correlates of personality traits more comprehensively (Kunisato et al., 2011). Lastly, the administration of the Rorschach is no longer standardized. The plates are presented on a screen and, because subjects are not allowed to move, they cannot hold and rotate the cards. Moreover, the inquiry is not conducted, so analyses are based solely on spontaneous responses. Asari et al. (2008, 2010a, 2010b) tried to bypass these limitations by providing participants with a MRI-compatible button press, so that they were able to rotate the image while in the scanner. Furthermore, the authors conducted post-experimental interviews outside the scanner to inquire as to where the percepts were seen.

Introducing a New Research Design

Recently, personality neuroscience is emerging as a new field of research that attempts to link biological variables to existing stable patterns of emotion, cognition, motivation, and behavior (Canli, 2008; DeYoung, 2010, DeYoug & Gray, 2009). The aim of personality neuroscience is to deepen and refine neurobiological and psychological theories of personality using techniques such as fMRI in resting state conditions (Ciuciu, Varoquaux, Abry, Sadaghiani, & Kleinschmidt, 2012; Lei, Yang, & Wu, 2015). Personality neuroscience "entails the examination of how variability among individuals on cognitive, emotional, motivational, or behavioral dimensions (e.g., extraversion, intelligence, empathic ability) is related to neural variables" (Mar, Spreng, & DeYoung, 2013, p. 674). However, personality constructs underlying numerous personality tests, and the Rorschach in particular, are explained by a pattern of various underlying factors that mostly vary together. Early research conducted on the detection of cognitive and somatosensory brain processes (de Ruiter et al. 2007; Hamilton et al. 2011; Seminowicz et al., 2004; Walter et al., 2009) have mainly investigated aspects of functional segregation.

However, a change in perspective has been introduced, so that recent literature has focused on the study of functional integration and patterns of brain connectivity, instead of investigating aspects of functional segregation and isolating regions functionally specialized in performing specific tasks. Moreover, given that several studies of cerebral metabolism (Raichle & Gusnard, 2002; Raichle et al., 2001) revealed a low energy increment of cerebral task activity (about 0.5–1.0%) compared to resting state conditions (about 60–80%), the examination of resting state neural activity has been introduced. In order to outline a new research design allowing us to better understand the psychological functions underlying Rorschach variables, we examined the concept of cerebral intrinsic activity, resting-state, and large scale resting state brain networks (rs-lsbn).

Resting-state neuroimaging is based on the identification of low-frequency spontaneous fluctuations in broad cerebral areas while the subject does not perform a specific task. A large part of the daily activities of the mind are internal and performed without external stimuli (Buckner & Vincent, 2007). During this particular state of consciousness, the subject is monitoring information such as feelings and body position, free association of thoughts that relate to past experience, inner speech, mental images, emotions, working memory, and planning for future events (Bar, 2009; Carhart-Harris & Friston, 2010; Raichle, 2010; Shulman, Hyder, & Rothman, 2009). The brain at rest, then, engages in intrinsic activity, defined in the literature as the default mode network (DMN), baseline state, and conscious resting-state (Raichle & Snyder, 2007). The DMN consists of spontaneous and simultaneous neuronal oscillations of anatomically segregated areas of the brain that are more metabolically active at rest when a person is not focused on external demand. Thus, the DMN turns off during goal-oriented activity and the task positive network (TPN) is activated.

In addition to the DMN, the literature has highlighted the presence of important rs-lsbn with visual, motor, linguistic and attentive functions at rest (Raichle et al., 2001). Several of the most recent resting-state networks studies have in fact reported inter-individual differences in functional intrinsic connectivity related to psychological traits, such as social competence (Di Martino et al. 2009), risk-taking (Cox et al., 2010), aggression (Hoptman et al., 2009), and cognitive efficiency (Andrews-Hanna et al., 2007). Although there is still a lack of complete agreement with regard to what could be a unique measure of rs-lsbn and the data are continuously updated, 10–11 principal networks have been identified (Rosazza & Minati, 2011): DMN, sensorimotor component, executive control component, visual components, auditory component, temporo-parietal component, and lateralized fronto-parietal components.

Currently, resting-state fMRI has been extensively used in neuroscience because of its advantages (He, 2011; Lei et al., 2015; Lei, Zao, & Chen, 2013; Smith et al., 2009). The most important requisite of resting-state spontaneous oscillations is their high test-retest reliability, indicating that rs patterns are stable across time (DeYoung et al., 2010; Van Dijk et al., 2009; Zuo et al., 2010). Moreover, this technique allows the detection of a wide range of brain regions correlated with psychological traits simultaneously (Lei et al. 2015). Crucial to introducing our innovative research design is the finding that most of the major brain networks that are involved in a task are also detectable in the brain at rest, and that these patterns are impressively similar to the networks activated by a wide spectrum of cognitive-behavioral tasks (Laird et al., 2011; Smith et al., 2009). Moreover, models of functional connectivity during rest summarize coactivation patterns that reflect individual history and experience (Sporns, 2013). Recent experiences, as well as consolidated abilities, may leave a "memory trace" within brain function and spontaneous fluctuations may be involved in the process of memory consolidation.

Recent studies in personality neuroscience hypothesized that rs-lsbn may have a direct relationship with psychological traits (Adelstein et al., 2011; Canli, 2004; DeYoung et al., 2010; Lei et al., 2013). In a very recent study, resting-state neuroimaging was employed as a powerful tool to analyze the brain structure and the neuronal correlates of the Big-Five constructs and extraversion-introversion traits (Lei et al., 2015). Researchers found a significant relationship between the DMN and Extraversion. Moreover, Adelstein and colleagues (2011) found that personality domains measured by the NEO-PI-R (Costa & McCrae, 1992) correctly predicted resting-state functional connectivity (RSFC) between hypothesized patterns of regions. In particular, Neuroticism predicted RSFC involved in self-referential processing, emotional regulation, and fearful anticipation; Extraversion predicted RSFC involved in social attention, face recognition, motivation and reward; Openess to Experience predicted RSFC implicated in working memory and creativity; Agreeableness predicted RSFC involved in social and emotional attention; Conscientiousness predicted RSFC implicated in planning and future-oriented episodic judgment. Generally, personality neuroscience studies confirmed the utility of examining the synchronous cerebral connectivity at rest to identify neural markers of complex traits, such as personality traits.

On the basis of the aforementioned neuroimaging evidence, we have highlighted that rs-lsbns appear to be linked to psychological functioning and to specific personality features. Based on these findings, we propose a new research design that employs RSFC analyses to explore the brain's functional architecture in relation to psychological constructs of Rorschach variables related to perceptual styles and personality traits. In this research design, each fMRI scan should be a measure taken in rest condition and participants should be instructed to rest with their eyes open in passive fixation. The administration of the Rorschach would be assessed outside the fMRI scanner, ensuring a more ecological setting, and the cerebral intrinsic activity would be analyzed without a task condition. Therefore, this new research design would allow bypassing most of the critical issues related to the administration of the Rorschach during fMRI scans. Moreover, investigating resting states would allow researchers to avoid artefacts related to phonation, fluent speech, and movements of the head.

At this point, our attention should be directed to formulating hypotheses about Rorschach variables (Exner, 2003). As we discussed above, resting state patterns are stable over time and recent research has related these patterns to personality traits. Thus, the first group of hypotheses concerns the relationship between the RSFC analyses identified by Adelstein and colleagues (2011) and Rorschach variables considered to identify trait characteristics. The intrinsic connectivity between regions involved in the evaluation of self and others, as well as in socially directed thought, such as determining or inferring the purpose of others actions (dorsomedial prefrontal cortex of the DMN), may be predicted by Rorschach variables from the Self Perception and Interpersonal Perception clusters. Moreover, Affect cluster variables (particularly WSumC) may predict the intrinsic connectivity between regions involved in the processing of positive emotions (orbitofrontal cortex, insula, and amygdala areas; Lei et al., 2015), as well as the processing of reward and motivation (DeYoung et al., 2010). We also hypothesize a negative correlation between a high lambda style and regions involved in cognitive flexibility (anterior cingulate cortex and dorsolateral prefrontal cortex; DeYoung et al., 2009; Jung et al., 2010). Particularly, variables of Interpersonal Perception and the Coping Deficit Index (CDI) may predict connectivity with regions involved in altruism and social information processing (cortex and posterior temporal cortex; Kober et al., 2008). Finally, we hypothesize that the Controls cluster may predict the activity of regions involved in planning and self-discipline (lateral prefrontal cortex and medial temporal lobe; DeYoung & Gray 2009; DeYoung et al., 2010).

Further hypotheses may arise from the recent resting state literature related to specific diagnostic groups. For example, the DMN has been investigated in patients with schizophrenia. Broyd et al. (2009) reported that weak regulations of competition between the DMN and the task-positive network in patients with schizophrenia reflected over-mentalizing and excessive vigilance to the external environment. Therefore, a suitable hypothesis would be that of a relationship between excessive competitions between networks and the Hypervigilance Index (HVI). Moreover, increased connectivity between the DMN and other resting state networks is associated with attention deficits related to the intrusive role of hallucinations and delusional experiences. This last finding may contribute to the hypothesis of a relationship between increased connectivity and the

Perceptual-Thinking Index (PTI). The DMN has also been associated with depression and anxiety (Broyd et al., 2009). It is involved in free mental processes and in cognitively passive tasks. Its activation correlates with the human ability to roam with the mind, to think about past experiences, or to imagine the future (Rosazza & Minati, 2011). DMN connectivity is related to ruminative and self-referential thinking, and patients with depressive mood disorders show increased functional connectivity in affective regions (e.g., the thalamus) that may interfere with cog- Q1 nitive processing (Greicius, Supekar, Menon, & Dougherty, 2007). Consistently, Sheline et al. (2010) found that people with a diagnosis of depression presented deficiency in the suppression of the DMN (particularly the medial prefrontal cortex) and that they experienced long periods of intense negative rumination. These findings suggest a relationship between increased functional connectivity or deficit in the suppression of the DMN and Vista (V) responses, as well as the Depression Q2 Index (DEPI).

Using fMRI techniques to investigate construct validity in the psychological and clinical domains is a recent field of research developed over the past 20 years. The research design presented here seems to us of particular interest for future studies in the field of resting-state fMRI, which has not yet been sufficiently explored in relation to psychological testing in general, and to the Rorschach test in particular. The aim of this new research design is to identify the latent structures that shape the resting-state lsbn and that simultaneously predict Rorschach variables. This research design would ensure methodological rigor of the standardized administration of the Rorschach in a more “natural” setting, and may avoid technical artefacts related to the sources of noise involved in fMRI. To our knowledge, the Rorschach and fMRI literature has not yet explored the relationship between neural correlates detected during the recording of intrinsic activity at rest and Rorschach variables. Thus, correlating resting-state networks to Rorschach variables may contribute to the growing literature on the validity of the Rorschach and may provide a biological foundation for some Rorschach variables.

Conclusion

How can neuroimaging techniques be concretely of use with respect to issues so far articulated? Is it possible to contribute to the Rorschach nomological network through the analysis of resting-state large-scale brain networks? Cognitive psychology has long adopted neuroimaging techniques to study brain functioning at the level of simple phenomena, such as memory, language, or sensorimotor tasks, but exploring more complex phenomena, such as psychopathology and personality, is more challenging. Neuroscience and clinical psychology have often traveled in parallel, avoiding possible points of contact but are often moving in the same direction. Indeed, on closer inspection, this fracture was in part a consequence of Freud's "failed attempt" to substantiate his theory through the use of neuroscience, hampered by a lack of appropriate tools (Northoff, 2012a, 2012b). From this point of view, it is likely that Freud would today be very interested in neuroscience and that he would finally have available tools to investigate the psyche in more sophisticated ways. On the other hand, Pulver (2003) draws attention to the importance of having realistic expectations with regard to the potentiality of neuroscience. Faced with a technology enabling the observation of the brain in vivo and providing us with images of its functioning, we risk falling into the opposite error of that mentioned above, considering that neuroimaging is to mental health what radiography is to a bone fracture. In this case, beyond the initial blind enthusiasm for the potential of neuroimaging (McCabe & Castel, 2008), the risk would be a subsequent total distrust. So what is the correct position? Rather than talking about a correct position, we could talk about a beneficial location.

It seems, in fact, that these two paths will cross at a point beyond which, in order to make progress together, they will need each other. Clinical approaches formulate theories to explain psychological phenomena; neuroscience shows the brain functions that underlie these processes and human behavior by providing access to information that would otherwise not be available. Fonagy and Target (2003), speaking of clinical and research approaches, consider that we should not see a evolutionary relationship between conceptual research (which generates hypotheses) and empirical research (which evaluates assumptions), but rather a complementary one. One could consider these two positions as being in a state of reciprocal tension: each induces the other to clarify itself. From those premises it is our opinion, therefore, that the progressive development of neuroimaging techniques, both with respect to the accuracy and to the enlargement of the objectives of investigation, can effectively contribute to the development of knowledge in psychopathology and psychodiagnosis. This could help put both the Rorschach and the dialogue between neuroscience and clinical practice, as well as the relationship between mind and brain, in a new light.

In conclusion, in the present review we aimed to investigate how neuroimaging and brain stimulation techniques may contribute to the development of knowledge about the psychological functions underlying Rorschach variables. The innovative research design that we have proposed and discussed may significantly contribute to the nomological network of the Rorschach. However, some limitations are worth noting. First, within the field of neuroscience, it is still not clear which are the specific psychological functions involved in resting state networks

(Read et al., 2010). Second, given that Rorschach variables tap both implicit and explicit psychological processes, the constructs related to Rorschach variables are not easy to define. As Mihura and colleagues (2012) stated in their recent meta-analysis of Rorschach variables:

> Appropriate criteria in the nomological network for Rorschach variables need to be specified to parallel the performance-based coding of inkblot-delimited attribution and behaviors [...] The coding of these response behaviors produces valid constructs but also constructs that are uniquely shaped (and limited) by the task. (Mihura et al., 2012, p. 32)

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Summary

Neuroscience and clinical psychology have often traveled in parallel, avoiding possible points of contact but often moving in the same direction, at least because they are anchored to each other by having a common object of study: the human mind and its manifestations. Recently, neuroimaging techniques have completely revolutionized the way we conceive the study of the brain, allowing us to switch from an anatomical-segregation position to a more functional integration view of brain mechanisms, based on networks between various cerebral areas not necessarily anatomically close to each other. The aim of this article was to explore and review the neuroimaging fMRI literature on the Rorschach in order to contribute to the knowledge base on psychological and personality traits that form the basis of the Rorschach. Therefore, we point out the principal methodological issues related to free flow speech responses during scanning and artefacts associated with head motion and changes in the sinus cavities and the pharynx during phonation. The conscious resting state in humans is supported by an extensive network of associative parietal areas that can be further hierarchically organized in a network of fronto-parietal working memory, driven in part by emotions, and working under the supervision of prefrontal executive networks. At rest, in addition to the default mode network (DMN), the literature reports the presence of other important networks with visual, motor, linguistic, and attentive functions. Indeed, these networks seem to be linked to the psychological functioning of individuals. Crucially, most of the networks detectable in the brain involved in a task are also identifiable in the brain at rest. Thus, we introduce a resting state fMRI research design to compare the diagnostic meaning of some Rorschach variables and the structure and functions of resting-state state brain networks (rs-lsbn). Specifically, we aimed to relate Rorschach variables to rs-lsbn by using fMRI to analyze cerebral intrinsic activity. With this research design, the administration of the Rorschach test (The Comprehensive System, Exner, 1993) would take place outside the fMRI. This condition would allow the bypassing of important methodological limitations, such as the presence of fMRI artefacts during fluent speech, the non-ecological setting for Rorschach administration, and, finally, the low temporal resolution due to the nature of the BOLD signal detected during scanning.

Sintesi

Neuroscienze e psicologia clinica hanno spesso viaggiato parallelamente, evitando il più possibile punti di contatto ma muovendosi tuttavia molto spesso nella stessa direzione, se non altro perché ancorate l'una all'altra dal fatto di avere un comune oggetto di studio: la mente umana e le sue manifestazioni. Attualmente le tecniche di neuroimaging hanno completamente rivoluzionato il modo di concepire lo studio del cervello, consentendo di passare da una posizione di *segregazione* anatomica ad una visione del cervello e dei suoi meccanismi di *connettività* funzionale più ampia, basata cioè sui network di aree cerebrali non necessariamente anatomicamente contigue. L'obiettivo di questo articolo è di esplorare e percorrere nell'ambito della letteratura sul neuroimaging una revisione degli studi condotti con l'utilizzo dell'fMRI e il test di Rorschach, al fine di contribuire allo sviluppo delle conoscenze relative al funzionamento mentale e di personalità che stanno alla base del test. Abbiamo dunque sottolineato le principali criticità ed i problemi metodologici relativi all'analisi del fluire libero dell'eloquio durante una scansione fMRI e agli artefatti associati al movimento del capo e alla fonazione. L'esistenza di stati consci di resting state negli individui è supportata in letteratura dall'individuazione di un'estesa rete associativa di aree parietali gerarchicamente organizzata in una rete fronto-parietale di working memory, guidata in parte dalle componenti emotive, sotto la supervisione di una rete prefrontale esecutiva. In condizioni di rest, oltre

al DMN, la letteratura evidenzia la presenza di altri importanti network con funzioni visive, motorie, linguistiche ed attentive che risultano essere collegati con il funzionamento psicologico. Il dato più interessante consiste nel fatto che la maggior parte dei network che sono rilevabili nel cervello durante l'esecuzione di un compito possono essere identificati nel cervello anche in condizioni di rest. Abbiamo dunque proposto un nuovo disegno di ricerca in cui alcune variabili Rorschach possono essere messe in relazione con i resting-state state brain networks (rs-lsbn), identificati attraverso l'uso della fMRI per analizzare l'attività cerebrale intrinseca. Questo disegno di ricerca prevede che la somministrazione del test di Rorschach sia condotta all'esterno dello scanner, consentendo in questo modo pertanto di evitare le limitazioni metodologiche relative agli artefatti implicati nell'analisi del fluent speech durante la somministrazione del test in macchina, le caratteristiche scarsamente ecologiche di tale setting di assessment ed infine la bassa risoluzione temporale da attribuire alla natura intrinseca del segnale BOLD durante la rilevazione del fluire libero dell'eloquio.

Résumé

La neuroscience et la psychologie clinique ont souvent voyagé en parallèle, évitant les points de contact possibles, mais se déplaçant souvent dans une même direction, étant liées l'une à l'autre par un objet d'étude commun: l'esprit humain et ses manifestations. Les techniques de neuro-imagerie ont complètement révolutionné la façon dont nous concevons l'étude du cerveau et nous permettent de commuter entre une position de *ségrégation anatomique* et une vue plus fonctionnelle des mécanismes cérébraux, basée sur les réseaux entre aires cérébrales diverses. L'objectif de cet article est d'effectuer une revue de la littérature sur la neuro-imagerie et les études cliniques réalisées avec l'imagerie par résonance magnétique fonctionnelle (IRMf), afin de contribuer au développement de la connaissance relative au fonctionnement mental et de personnalité basé sur le test du Rorschach. Nous avons donc souligné les principales difficultés et les problèmes méthodologiques relatifs à l'analyse du flux libre de l'élocution pendant l'examen d'IRMf, ainsi qu'aux artéfacts associés au mouvement de la tête et à la phonation pendant cet examen. L'existence d'états conscients de repos ("resting state") chez les individus est abordé dans la littérature par la découverte d'un vaste réseau associatif des zones pariétales organisées hiérarchiquement dans un réseau fronto-pariétal de la mémoire de travail, dirigé en partie par des composantes émotionnelles, et sous la supervision d'un réseau exécutif préfrontal. Pendant les conditions de repos, en plus du réseau du mode par défaut (RMD), la littérature signale la présence d'autres réseaux importants avec fonctions visuelles, mnésiques, linguistiques et d'attention qui sont liées au fonctionnement psychologique. L'élément le plus intéressant est le fait que la plupart des réseaux qui sont détectables dans le cerveau pendant l'exécution d'une tâche peuvent être identifiés dans le cerveau également dans des conditions de repos. Nous avons donc proposé une nouvelle méthodologie de recherche dans laquelle les variables Rorschach peuvent être mises en relation avec les réseaux détectables en condition de repos, identifiés en utilisant l'IRMf pour analyser l'activité cérébrale intrinsèque. Cette méthodologie de recherche prévoit que l'administration du Rorschach soit effectuée à l'extérieur de l'appareil IRMf, permettant ainsi d'éviter les problèmes méthodologiques relatifs aux artefacts liés à l'administration du test dans le scanner, aux caractéristiques peu écologiques de ce contexte d'évaluation, et enfin à la basse résolution temporelle du signal BOLD pendant des tâches de fluence verbale et d'élocution libre.

Resumen

Neurociencia y psicologia clinica a menudo han viajado en paralelo, evitando lo mas posible puntos de contacto pero al mismo tiempo moviendose en la misma direccion, eso porque estan conectadas por el mismo objeto de estudio: la mente humana y sus manifestaciones. Actualmente las tecnicas de neuroimaging ha revolucionado totalmente la forma en que se concibe el estudio del cerebro, permitiendo el pasaje desde una posicion de segregacion anatomica hasta una vision del cerebro y de sus mecanismos de connexion funzionales mas ancha. El objetivo de este papel es el de explorar y actuar una revision de la literatura sobre el neuroimaging y los estudios del fMRI y del test de Rorschach, para contribuir al avanzamento del conoscimento del funcionamiento mental y de personalidad que rapresentan la base del test. Entonces hemos estresado las principales criticidad y los problemas metodologicos del analisis del libre flujo del discurso durante una sesion de fMRI y los artefactos conectados al movimento de la cabeza y a la fonacion. La existencia de estrado consientes de resting state en las personas està apoyada el la lecteratura por la individuaccion de una larga red de asociasion de las areas parietal organizada jerárquicamente en una red fronto-parietal de working memory, conducida en parte por las componentes emotivas, bajo la supervision de una red prefrontal esecutiva. En condiciones de rest, mas que al DMN, la literatura maestra la presenzia de otros importantes networks con funciones visivas, motorias, linguisticas y de atencion que estan conectados con el funzionamento psicologico. El dado mas interesante es el hecho que la majoria de los networks que se pueden detectar en el cerebro durante la ejecucion de una tarea puden ser identificados en el cerebro tambien en condiccion de rest. Entonces hemos propuesto un nuevo debujo de busqueta en que algunas variables Rorschach pueden ser puestas en relation con los networks detectados en condicciones de rest (rs-lsbn), identificados a travez de la analisis de la acrtividad cerebrales intrinseca. Este debujo de busqueta implica que la administracion del test de Rorschach sea hecha fuera de lo scanner, permitiendo aci de evitar las limitaciones metodologicas cerca los artefactos implicados el la analisis del fluent speech en la administracion del test en la machina, las caracteristicas poco ecologicas de este setting de assessment y ademas la baja resolucion temporal que se pueden atribuir a la natura de la senal BOLD durante la rilavacion del flujo libre del discurso.

