The powerful pull of brain images

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Abstract

Recent advances in neuroimaging, especially those springing from the use of functional magnetic resonance imaging, have produced a large body of knowledge that is beginning to weaken the attitude of rejection upheld by many developmental and social psychologist against biologistic approaches to human development. Findings in the area of neuroscience have contributed to a better understanding of developmental phenomena such as self-regulation, aggression or empathy. But despite the promising, new avenues of research opened up by neuroimaging techniques, some criticisms have recently arisen that should be considered regarding the reliability of these techniques. In the near future the convergence of neuroscience, genetics and classic methods which have proved their usefulness in the study of human behaviour, promises a better understanding of human development.

Keywords: Neuroimaging, genetics, human development.

El enorme poder de atracción de las imágenes cerebrales

Resumen

Los avances recientes en neuroimagen, especialmente debidos al uso de las técnicas de resonancia magnética funcional, han producido un vasto cuerpo de conocimiento que ha empezado a debilitar la actitud de rechazo que muchos psicólogos evolutivos y sociales sostenían hacía los enfoques biologicistas del desarrollo humano. Los hallazgos en el campo de las neurociencias han contribuido a un mejor conocimiento de fenómenos evolutivos como la auto-regulación, la agresividad o la empatía. Pero, a pesar de las prometedoras perspectivas de investigación que las técnicas de neuroimagen han abierto, recientemente se han suscitado algunas críticas con respecto a la fiabilidad de estas técnicas, que deberían ser tenidas en cuenta. En el futuro inmediato, la convergencia de la neurociencia, la genética y de métodos clásicos que a lo largo de las últimas décadas han demostrado su utilidad para el estudio de la conducta, son una promesa para una mejor compresión del desarrollo humano.

Palabras clave: Neuroimagen, genética, desarrollo humano.

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Neuroimaging and the nature versus nurture debate

Although the majority of theories formulated by evolutionary psychologists over the last century paid little attention to the discoveries made in fields such as genetics and neuroscience, it seems that finally, after many insistent efforts, these findings are now starting to arouse a certain degree of interest among human development researchers. Although this neglect may, to a large extent, be due to the scarcity of data on the structural and functional organisation of the brain (Cicchetti & Thomas, 2008), we should also acknowledge that many psychologists were fairly reluctant to accept more biologistic approaches, such as those proposed by behavioural genetics, ethology, evolutionary psychology and neurobiology.

During the 1970s, the confrontation between advocates of environmentalist theories and those who sustained that some human behaviours had an instinctive base was bitter and fierce. When some authors, such as psychologist Richard Herrnstein, or ethologists E. O. Wilson or Richard Dawkins, suggested that certain traits and behaviours were inherited and that natural selection moulded a pre-existing human nature, they became the object of extremely harsh criticism which overstepped by far the boundaries of normal debate in the academic field. Accused of being fascist and racist, their theories were regularly slandered and distorted and their lectures often boycotted. These attacks had a clearly political undertone, since more environment-based psychological proposals had always been more readily accepted by the ideological left, whose attempts at changing the political and social system gained strength and validity from the belief that human nature could be modified. As Trotsky put it, "producing a new and improved version of man is the future task of Communism". Consequently, anything that placed limits on this supposed modifiability was viewed with a great deal of suspicion. In this context, it is hardly surprising that Stalin went so far as to prohibit genetic research and imprison many geneticists on the charge of being counterrevolutionaries. Those who denied the existence of an instinctive human nature also adopted a highly moralistic tone, since they believed that by attacking innatism they were in fact attacking racism, sexism and, in general, social inequality. This attitude of rejection became widespread among many researchers and psychosocial intervention professionals of the ideological left, and even today it is still considered politically incorrect to acknowledge some of the implications of Darwinist evolution, such as, for example, the fact that men and women have different natures.

At the other end of the ideological spectrum, political use was also made of biologistic theories, especially those that defended the hereditary nature of certain human traits, such as intelligence. These theses were forwarded by those who supported cutting US government funding for compensatory programmes, such as Head Start, which aims to prevent educational failure and dropout among underprivileged minority groups.

The general reluctance to accept findings from research areas that defended the role of genes, evolutionist explanations or cerebral bases for human behaviour began to crumble as the result of several key discoveries. Let us remember, for example, the role played by ethology in the formulation of the attachment theory (Bowlby, 1969), and the findings of behavioural genetics of correlations between inheritance and environment or the differentiation between shared and non-shared environment (Oliva, 1997). But what really began to break down the walls which kept these theories safely outside the area of interest of child development researchers were the results provided by studies using neuroimaging techniques. It was these beautiful coloured photographs of the brain in action, taken using functional magnetic resonance imaging (fMRI) techniques, that achieved in just a few years what many geneticists and neurobiologists had been trying in vain to accomplish for decades. Today, we are all mesmerised by these wonderful images, and neuroimaging studies are frequently featured in specialist journals. To such an extent, in fact, that in addition to those journals which focus specifically on this field, such as Brain Imaging and Behavior, other publications such as *Development and Psychopathology* or *Biological Psychology* have also dedicated numerous monographic issues to this very subject since 2008. Moreover, references to neuroscientific findings are also becoming increasingly frequent in more mainstream books, journals and newspapers.

Although similar techniques such as positron emission tomography (PET) had been available for years, they were unsuitable for use with children and adolescents, since they were based on radioactive isotopes. fMRI, on the other hand, can be used from the age of 6, age at which the majority of children are capable of carrying out the required tasks while remaining in an almost completely closed off space for a half-hour period.

It is true that techniques such as fMRI cannot be used with younger children, but as Sadato, Morita and Itakura (2008) have pointed out, direct research into the working of the brain in children is not the only effective way of studying cerebral development. Thus, the combination of findings from cognitive neuroscience and evolutionary psychology, on the one hand, and the results of fMRI studies with adults on the other, may be of enormous use in charting the maturing process of certain brain areas during childhood, as indeed suggested by the authors cited above in relation to the development of self-awareness and self-recognition in young children.

Nevertheless, it is highly likely that the development of new technologies will enable neuroimaging techniques to be used even with babies in the near future. Near-infrared spectroscopy (NIRS), which utilises near-infrared light and may be applicable to infants in natural conditions, is one of the most promising approaches for use with younger children (Aslin & Mehler, 2005).

Neuroimaging and genetics: a promising collaboration

Achievements in the neurosciences have coincided with the spectacular advances also made in genetics, which have gone well beyond the classical methods of behavioural genetics. Today, the combination of neuroimaging and molecular genetics techniques enable us not only to compare the psychological and behavioural differences of subjects with allelic disparities in certain specific genes, as Caspi et al. (2002) did in their study on the role of the monoamine oxidase A (MAOA) gene, but also to compare (using neuroimaging techniques) the brain structure or activity of genetically different groups of subjects, in a practice that has become known as Imaging Genetics (see the monographic issue dedicated to these techniques by *Biological Psychology* in 2008). This new area of knowledge substitutes brain activation for behavioural traits as the phenotype variable to be related to genetic differences. Imaging Genetics also uses twin studies (focusing on twins with different degrees of genetic similarity) to analyse both genetic and environmental influences on certain brain functions (Wolfensberger et al. 2008). However, twin studies have their limitations, since they do not identify the influence of specific genes, which is why the most common approach today is based on analysing the association between variations in one specific gene and changes in the brain structure or functioning (measured using magnetic resonance imaging techniques). The genes selected for study are usually those involved in the metabolism, release or reception of neurotransmitters, which, like dopamine or serotonin, are related to emotional and cognitive functions. Other candidates are those genes linked to brain genesis and development, the maturation of the executive attention circuit or the volume of grey matter in the prefrontal cortex. The aim of this method, which combines neuroimaging and genetic techniques, is to detect the brain processes which mediate the relationship between genetic variations and behavioural differences.

One of the most studied genes is the DRD4, which is related to the reception of dopamine, a neurotransmitter involved in cognition processes, behaviour and the emotions, which plays an important role in the development of the prefrontal cortex. Children who possess the 7-repeat and 521T variants of this gene are 10 times as likely to present disorganised attachment (Gervai et al., 2005). Furthermore, the dopamine reception system is associated with problems such as attention deficit hyperactivity disorder (ADHD), schizophrenia and substance abuse. This has prompted Bernier and Meins (2008) to suggest that the combination of clearly inadequate parental care and the possession of certain variations of the DRD4 gene places children at a high risk of developing certain psychological and psychiatric disorders, the primary manifestation of which would be disorganised, insecure attachment.

Other genes which are also associated with dysfunctional social behaviour are the DRD2, related to dopamine reception, and the HTR2A, linked to serotonin receptors. In a study with adults, the first of these genes was found to be associated with anxiety or ambivalence in the attachment model, while the second was associated with avoidance (Gillath, Shaver, Baek & Chun, 2008).

Some critiques of neuroimaging

Despite the promising new avenues of research opened up by neuroimaging techniques regarding the study of the brain and human development, some remain sceptical and warn of the limitations of these new methods (Dobbs, 2005; Hunt & Thomas, 2008; Logothetis, 2008). As some of these authors have pointed out, although we may think that magnetic resonance imaging offers direct photographs of the brain in action, we should not forget that we are in fact talking about images created by complex statistical calculations carried out by sophisticated software based on a large body of collected data. Furthermore, following the data gathering process, researchers are always obliged to adjust results in order to allow for deviations in brain size, head movements during the session or the location of certain brain structures; and this adjustment may result in errors and lack of precision throughout the whole process. The colouring process also tends to magnify activation differences between different brain structures, and it is possible that the activation of nuclei formed by only a small number of neurons may go unnoticed in the final image. More importantly, the neuronal activity detected by these images is not always easy to interpret, since it may be prompted by diverse, and very different, causes. In some cases it is even difficult to ascertain whether what we are seeing are excitatory or inhibitory processes, a confusion which may lead to very different interpretations of the brain mechanisms and psychological processes involved in a specific task. Moreover, we should not forget that despite the fact that, among neuroscientists, the idea of interconnected neuronal networks is more widely accepted than that of mental modules (although both proposals are perfectly compatible), brain images give the impression that the brain is formed by a series of encapsulated modules, thus giving rise to what Dobbs (2005) termed 'new phrenology'.

The most recent criticism of these studies in the field of the neurosciences was levelled by Vul, Harris, Winkielman and Pashler (2009), who point out that many of the correlations between fMRI-based brain function measures and questionnaire-based behavioural traits are so high as to be practically impossible, exceeding even the reliability indexes of correlated measures. The study conducted by these authors, based on interviews with researchers in this specific field, identified important methodological problems in the majority of studies examined, with many correlation coefficients having been vastly overestimated. Bearing in mind that many of these studies focused on very small sample groups and therefore had a very low statistical power, it is probable that without this artificial increase many correlations would not even have reached statistical significance level.

Despite all these limitations, many of which will presumably be resolved in the near future, there can be no doubt that neuroimaging techniques will continue to provide brain activity data that are vital to improving our understanding of development during childhood and adolescence. It is true that they are, to a certain extent, reductionist in nature, but this may in fact be necessary in order to develop explanatory models and theories with an adequate level of precision. At the end of the day, psychological concepts are only ever approximate models, as speculative as those constructed from neurobiological data, if not more.

Nevertheless, we should still adopt a cautious approach to many neuroscientific findings, since it is likely that, as neuroimaging techniques improve, new explanations based on new findings will arise for certain behaviours that will not always coincide with previous ones. For example, in relation to risk-taking behaviours during adolescence, the first studies pointed to a deficit in the activation of the mesolimbic reward system, which prompted adolescents to compensate by taking more risks in order to obtain the same pleasurable sensation; however, more recent research now suggests just the opposite, i.e. a hyperactivation of the reward system (Oliva, 2007). Something similar seems to have occurred in relation to antisocial behaviour, since, although as Rodrigo states in her paper, studies distinguish between two types of aggressive subjects, one with low emotional reactivity and little empathy, and another with high emotional reactivity and poor regulation or control of these negative emotions (Crowe & Blair, 2008), a recent study complicates things further by stating that some youths with aggressive conduct disorder show a greater activation of the reward system when contemplating another's pain, which is basically equivalent to saying that they feel pleasure when thinking about someone else's suffering (Decety, Michalska, Akitsuki & Lahey, 2008).

It is true that neuroimaging techniques produce beautiful images of brain structures and functions, and the powerful pull they exert over many researchers working in diverse fields related to human behaviour is more than justified. It is probable that, as these techniques become more and more readily available, an increasing number of researchers will decide to incorporate neurobiological data into the design of their research projects focusing on development during childhood and adolescence. However, it is important also to continue working with classic techniques which, over the course of recent decades, have proved their usefulness in the study of human behaviour and its underlying psychological processes. It is from the convergence of data from studies using different methodologies that a better understanding of the processes involved in the psychological development of children and adolescents will arise.

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