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Locating Risk in the Adolescent Brain: Ethical Challenges in the Use of Biomarkers for Adolescent Health and Social Policy

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Abstract

Technological developments in neuroscience over the last 20 years have generated excitement about the potential of neuroscientific insights for the understanding of and intervention in children's and adolescents' behavior. This article introduces some ways in which new results from developmental cognitive neuroscience have been appropriated in the context of adolescent mental health. We also consider social and interpersonal factors that drive the use of neurobiological markers of mental disorders in pediatric psychiatry. Finally, we outline the current ambitions for using neurobiological biomarkers in adolescent mental health care and discuss some ethical challenges arising from the methodological, political, cultural, and social contexts of their application.

Introduction

The interest in neuroscientific expertise has spread rapidly beyond the laboratory, as interpretations about brain changes of young people increasingly provide an evidence base to guide psychiatric treatment, child-rearing, and policy. As researchers in neuroscience, psychiatry, and social science, we are interested in the interactions among science and the social, cultural, and political contexts of research. This paper examines ways in which new results from developmental cognitive neuroscience—in particular, brain changes discovered through neuroimaging techniques—have been appropriated in the context of adolescent mental health, reinforcing an emerging emphasis on neurobiological markers of mental disorders as diagnostic tools in pediatric psychiatry. We first outline current ambitions for the use of neurobiological biomarkers in adolescent mental health and social policy and then examine some scientific and ethical challenges that arise in the methodological, cultural, political, and social contexts of their application.

The New Science of the Adolescent Brain: Neuroimaging and Hopes for Biomarkers

Adolescent brain development became a major project in neuroscience following the first set of cross-sectional and longitudinal studies of children, adolescents, and adults using magnetic resonance imaging (MRI) technology in the 1990s [1]. For example, the correlation between structural and functional developments in brain regions revealed

through MRIs and performance on cognitive tasks that tap capacities such as impulse control and empathy has led neuroscientists and public commentators to link risk-taking and impulsivity—commonly associated with teenagers—to developmental processes in the brain during adolescence [2, 3].

Applying insights from neuroscience and determining whether the function, connectivity, or structure of an adolescent's brain signals the presence or risk of mental disorder or behavior like risk-taking is also of significance in the context of education and the law. For example, "neuroeducation" curricula based on preliminary neuroscience findings are on the rise [4], supporting intervention programs for reading difficulties like dyslexia [5] and forming the basis for commercially available educational programs for educators to improve student performance (e.g., the Florida-based BrainSMART [6]). Furthermore, neuroimaging data played a role in marshalling support for the abolition of the juvenile death penalty in 2005 [7]. It also has been used to demonstrate neuroscience's relevance to legal decision making about adolescent culpability, as one prominent neuroscientist advised the defense team of a 15-year-old detainee at Guantánamo Bay on the basis of data on the immaturity of the neurocognitive systems implicated in cognitive control and reward-seeking behaviors [8]. Neuroscientists and policymakers have appealed to similar data to refine or reform policy guidelines in the context of adolescents and driving [9], safer sex [10], voting age [11], and occupational health and safety [12].

These translations of neuroscience findings into policy coincide with psychiatry's recent shift towards identifying "biomarkers," neurobiological traces that promise more precise means of identifying disorders and their subtypes than current psychiatric classification systems that rely on signs and symptoms. These biomarkers are physiological indicators akin to neural "signatures" that are not themselves causes of disorders but instead may help predict the probability of onset of a future disorder as well as treatment outcomes [13, 14].

Ethical Dilemmas Surrounding the Use of Neurobiological Biomarkers for Youth

The use of neurobiological biomarkers, which appear to have enormous potential, raises a number of practical methodological, social, and political challenges that have ethical implications.

Methodological issues. Recently, the National Institute of Mental Health (NIMH) announced its intention to transform psychiatric diagnosis through the Research Domain Criteria (RDoC) framework, which prioritizes neurobiologically based research on mental illnesses, deploying tools like fMRI with the ultimate goal of constructing a new classification system based on brain structure and function [15]. However, this approach has met with criticism from psychiatrists [16]. And as neuroscientists, psychologists, and philosophers have pointed out in recent years, while neuroimaging is a more powerful

and objective tool for identifying abnormalities than subjective reports and interpretations of experience and behavior, its validity and reliability for detecting risk of abnormality is limited [17-19].

Abnormalities in brain structure and function do not map neatly onto clinical or behavioral diagnostic categories, which are not simply biologically based but have been created within a specific historical and cultural context and thus might not describe a single pathological process [20, 21]. It is likely, for example, that various underlying anatomic networks would produce the symptoms that collectively are referred to as attention-deficit/hyperactivity disorder (ADHD). Moreover, children receiving the diagnosis belong to a heterogeneous population and have comorbidities [22], making identification of definitive ADHD predictors difficult. Some researchers have moved away from psychiatric categories by attempting to identify the neural correlates of emotional states and traits, but without conclusive results [23].

Distinguishing "normal" from "abnormal" brain structure and function is itself difficult, particularly because the brain's plasticity during development means that children and adolescents are able to employ different or compensatory strategies to perform equivalent tasks. For example, two adolescents diagnosed with ADHD may have different patterns of brain activity during a given task because of their different developmental histories and the recruitment of different brain networks [24]. As an ADHD diagnosis can bring about dramatic changes in parenting and educational strategies and may require medication, such neural "signatures" on their own must be read with caution.

Additionally, it should be stressed that neuroscience can only provide *correlations* between adolescent brain changes and behavior, not causal statements. But practical decisions about health care, education, or legal responsibility premised on neuroscientific data either occur or do not [13].

Social issues. Although practitioners in medicine, education, and the law are interested in using neural signatures of disease to predict individuals' risk of future disease as well as their propensities for antisocial or risky behaviors (e.g., poor decision making, impulsivity), the use of neurobiological biomarkers to identify young people "at risk" warrants debate. For instance, researchers have suggested that the new biodeterminism, or overemphasis on brain structure and function to account for increased risk-taking behavior ascribed to adolescents, serves to obscure differences in life experiences or the role of socioeconomic inequalities that may also explain risk-taking behavior, which has serious social consequences [2, 25]. The shortcomings of these applications of neuroscience research have been acknowledged by neuroscientists themselves, including prominent brain development researcher Jay Giedd, who cautions

policymakers against basing decisions about individuals on group data and who emphasizes the role of context in making sense of adolescent behaviors [26, 27].

Neuroscientists have acknowledged the general absence of context in lab-based experiments used to identify biomarkers. For instance, research on adolescents' apparent drive to seek novel sensations and rewards has not explored the possibility that this risk-taking behavior is adaptive to particular social contexts, and substantial leaps have been taken to draw links between abnormalities in neurocognitive maturation in small, lab-based samples and large-scale national statistics on car accidents, teen pregnancy, and drug abuse in particular countries [28]. Singh and Rose note that the use of psychiatric biomarkers to predictively label young people as "at risk" can have a stigmatizing effect, associating them with antisocial or criminal behavior and potentially leading to medical intervention that ignores broader social contexts [13]. Stigma attached to mental health diagnoses disproportionately affects more vulnerable groups like adolescents, who may experience disruptions of identity formation, and for whom such stigma can be a deterrent from seeking diagnosis [29].

The plasticity with which psychiatric biomarker studies are concerned is itself an experience-dependent process that can only be understood in context. Increasingly, developmental, social, and cultural neuroscience theorizes the brain as encultured [30-32] or socioculturally *situated* [33]. To this end, researchers have stressed the value of biomarkers and individualized brain plasticity research *alongside* a consideration of environmental and socioemotional factors in identifying vulnerability to bipolar disorder [34].

Political issues. Neuroscience and government policy enjoy an increasingly close relationship: while national surveys on adolescent problem behaviors frame the puzzles that neuroimaging studies seek to explain, neuroscientific data are beginning to provide the evidence base for educational, clinical, and legal imperatives. As discussed above, neuroscientific data on cognitive control have been used in cases establishing the criminal culpability of adolescents [35], and neurobiological biomarkers that provide apparent indicators of future risk for antisocial behavior or mental disorder can be associated with assumptions about criminal behavior and psychopathology [13]. These stigmatizing predictions about possible future behavior may in turn influence legal argumentation and prosecution.

What might be called the neuroscientific model of responsibility and selfhood risks disempowering adolescents with a "blame the brain" heuristic that renders teenagers the passive subjects of their brains' development [36]. Teenagers and their parents are charged to "take control" of the teenagers' brains by understanding and intervening in brain development—and, in so doing, they both submit to the neurotherapeutic model and demonstrate their ability to make informed, autonomous decisions as individuals

stripped of any broader social context or influences [37]. This model of the proactive neurobiological self, then, points to the broader sociopolitical context—in which people come to think of themselves as subjects in need of treatment—and to the levelling effect of neuroscientific research that attempts to bracket off context. Biomarker research adds to the arsenal of individualized brain data a predictive metric that could lead to intrusive psychiatric intervention without the definitive presence of pathology. The moral imperative towards health and well-being of the general population is here shifted onto the individual [38], consistent with descriptions of (neo)liberal values of self-responsibility and self-management [39, 40], with potentially negative consequences for patients' self-management.

Conclusion

In spite of their limitations, brain-based biomarkers may be significant for psychiatry in the same way that neuroimaging is a powerful alternative to self-report and subjective interpretation, which may be unreliable as a means of prompting introspection [41] and of limited use with children and adolescents [42]. Neural biomarker studies may complement self-report [43], compensating for these methodological shortcomings. They may allow faster predictions of the efficacy of medications like selective serotonin reuptake inhibitors (SSRIs) [44] and enable earlier, preventative therapeutic interventions [45]. As these ambitious translations of biomarker research evolve, particularly in work with adolescents, it is crucial that researchers tread carefully through the ethical entanglements that emerge from the methodological, cultural, and social contexts within which the developing brain is situated.

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