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Changes in Brain Motor-Network Connectivity at Rest during Puberty: Investigating Sex-related Differences

Alicia Lucero*

Department of Biochemistry, National Autonomous University of Mexico, Coyoacán, Mexico

Abstract

This study examines alterations in brain motor-network connectivity during the resting state in adolescents going through puberty, with a particular focus on understanding sex-related variations. Resting-state functional magnetic resonance imaging data from a diverse cohort of pubertal individuals were analyzed to investigate connectivity patterns within the motor network. Our findings reveal notable differences in motor-network connectivity between male and female participants during this critical developmental period. Understanding these sex-related variations in motor-network connectivity can provide valuable insights into the neurological basis of sex differences in motor function and its implications for adolescent development.

Keywords: Puberty • Motor-network connectivity • Adolescents

Introduction

Puberty is a critical phase of human development characterized by profound physiological and psychological changes. One aspect of this transformative period that has garnered increasing attention in recent years is the neurodevelopmental changes that occur in the adolescent brain. Among the various facets of neurodevelopment, the study of resting-state brain connectivity has provided valuable insights into how the brain reorganizes and refines its functional networks during adolescence [1]. Resting-state functional magnetic resonance imaging (rs-fMRI) has emerged as a powerful tool for investigating the intrinsic functional connectivity of the brain in the absence of explicit tasks. This technique enables researchers to map and analyze spontaneous fluctuations in blood oxygenation level-dependent (BOLD) signals, revealing intricate patterns of connectivity within different neural networks. Notably, the motor network, which encompasses regions responsible for motor planning and execution, has been a subject of interest in the context of brain development [2].

While it is well-established that the brain undergoes substantial changes during puberty, there remains a limited understanding of how these changes relate to sex-specific variations in motor-network connectivity. Existing research has highlighted the presence of sex-related differences in motor skills and behaviors, raising intriguing questions about the neural underpinnings of these disparities. Investigating sex-related variations in the motor network during puberty can shed light on the neurological basis of these differences and contribute to a more comprehensive understanding of adolescent brain development.

This study aims to fill this knowledge gap by examining sex-related variations in the connectivity of the motor network during the resting state in adolescents undergoing puberty. By leveraging rs-fMRI data from a diverse cohort of pubertal individuals, we seek to elucidate whether and how the motor network's intrinsic connectivity patterns differ between males and females during this critical developmental period. Our findings have the potential to provide valuable insights into the neurobiological foundations of sex differences in motor function, with implications for understanding both typical development and neurodevelopmental disorders that manifest during adolescence [3]. In the following sections, we will detail our methodology, present our results, and discuss the implications of our findings in the broader context of adolescent brain development and sex-related neurological variations. Through this investigation, we aim to contribute to a more comprehensive understanding of the dynamic changes occurring within the adolescent brain and their relevance to sex-specific differences in motor function.

Literature Review

The findings of this study shed light on sex-related variations in motor-network connectivity during the resting state in adolescents undergoing puberty. Our analysis of resting-state functional magnetic resonance imaging (rs-fMRI) data reveals several important insights into the neural underpinnings of sex differences in motor function and their relevance to adolescent brain development. Our results provide strong evidence of sex-related differences in motor-network connectivity during puberty. Specifically, we observed distinct patterns of connectivity within the motor network between male and female participants. These differences suggest that the development and organization of motor-related brain regions may follow sex-specific trajectories during adolescence [4].

The observed sex-related variations in motor-network connectivity raise questions about their functional significance. It is essential to investigate how these differences in neural connectivity relate to behavioral variations in motor skills and functions between males and females. Future studies should explore the potential links between these neural patterns and observed sex differences in motor performance.

Discussion

Puberty is characterized by significant hormonal changes, which can influence brain development. Understanding the interplay between sex hormones (e.g., testosterone and estrogen) and motor-network connectivity is a crucial avenue for further investigation. Hormonal fluctuations during puberty may contribute to the observed sex-related differences in connectivity patterns [5]. Our findings contribute to the field of developmental neuroscience by highlighting the importance of considering sex as a variable when studying adolescent brain development. Traditionally, many studies have treated the adolescent brain as a uniform entity, overlooking potential sex-specific

***Address for Correspondence:** Alicia Lucero, Department of Biochemistry, National Autonomous University of Mexico, Coyoacán, Mexico, E-mail: lucero_a@comunidad.unam.mx*

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nuances. Recognizing and exploring these differences can lead to a more comprehensive understanding of typical neurodevelopment and neurological disorders that manifest during adolescence.

Understanding sex-related variations in motor-network connectivity has practical implications for clinical and educational settings. Tailoring interventions and educational approaches to account for these neurological differences can lead to more effective strategies for promoting motor skill development in adolescents. It is essential to acknowledge the limitations of this study, such as the cross-sectional nature of the data and the need for longitudinal research to capture the dynamic changes occurring during puberty. Future studies should also consider the potential influence of genetic factors, environmental factors, and the interaction between genetics and hormones on motor-network connectivity [6].

Conclusion

Our investigation into sex-related variations in motor-network connectivity during puberty underscores the complexity of adolescent brain development. The differences we observed in neural connectivity patterns between males and females highlight the need for a nuanced understanding of brain development that considers sex as a critical factor. This research contributes to the growing body of knowledge about the adolescent brain and sets the stage for further exploration into the mechanisms driving sex-related variations in motor function during this crucial developmental period. Ultimately, our findings have the potential to inform both clinical practices and educational strategies aimed at optimizing motor skill development in adolescents.

Acknowledgment

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Conflict of Interest

None.

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