Linking Brain Growth with Scientific Reasoning Ability and Conceptual Change During Adolescence

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Abstract: The hypothesis that an early adolescent brain growth plateau and spurt exists and that this plateau and spurt influence students' ability to reason scientifically and to learn theoretical science concepts was tested. In theory, maturation of the prefrontal lobes during early adolescence allows for improvements in students' abilities to inhibit task-irrelevant information and coordinate task-relevant information, which along with both physical and social experience influences scientific reasoning ability and the ability to reject scientific misconceptions and accept scientific conceptions. Two hundred ten students ages 13-16 years enrolled in four Korean secondary schools were administered tests of four prefrontal lobe activities, a test of scientific reasoning ability, and a test of air pressure concepts derived from kinetic-molecular theory. A series of 14 lessons designed to teach the concepts were then taught. The concepts test was then readministered following instruction. As predicted, among the 13- and 14-year-olds, performance on the prefrontal lobe measures remained similar or regressed. Performance then improved considerably among the 15- and 16-year-olds. Also as expected, the measures of prefrontal lobe activity correlated highly with scientific reasoning ability. In turn, prefrontal lobe activity and scientific reasoning ability predicted concept gains and posttest performance. A principal components analysis showed that the study variables had two main components, which were interpreted as an inhibiting and a representing component. Therefore, theoretical concept acquisition was interpreted as a process involving both the inhibition of task-irrelevant information (i.e., the rejection of intuitively derived misconceptions) and the representation of task-relevant information (i.e., complex hypothetico-deductive arguments and counterintuitive scientific conceptions about nonobservable entities). © 2000 John Wiley & Sons, Inc. J Res Sci Teach 37: 44-62, 2000