Developmental dyslexia may result from general deficits concerning rapid temporal integration of acoustic stimuli. Assuming that the effort of auditory temporal processing of speech and non-speech stimuli increases with presentation rate, fMRI measurements were performed in dyslexics and controls during passive listening to series of syllables and click sounds using a parametric approach. Controls showed a decrease in hemodynamic brain activation in the right and an increase in the left anterior insula as a function of increasing presentation rate of click as well as syllable trains. By contrast, dyslexics exhibited this profile of hemodynamic activation in the click condition only. As concerns syllables, activation in dyslexics did not depend on presentation rate. Moreover, a subtraction analysis of hemodynamic main effects across conditions and groups revealed decreased activation of the left and right anterior insula in dyslexics as compared to controls in both the click and the syllable condition. These results indicate, in line with preceding studies, that in healthy adults the insular cortices are involved in auditory temporal processing of non-linguistic stimuli. Furthermore, they demonstrate that these operations of the intrasylvian cortex extend to the linguistic domain. Crucially, our data suggest that the anterior insula represents an important neural correlate of deficient temporal processing of speech and non-speech sounds in dyslexia.