MAGNETIC RESONANCE SIMULATION IS EFFECTIVE IN REDUCING ANXIETY RELATED TO MAGNETIC RESONANCE SCANNING IN CHILDREN

To the Editor:

With the advent of high-resolution imaging techniques, it has become possible to study human brain development in vivo.[1–4] Magnetic resonance imaging (MRI) is the technique of choice because it is noninvasive and can provide exquisite anatomical detail, as well as show the development of brain activity patterns using developmentally appropriate paradigms.[1–4] This is important not only for our understanding of typical brain development, but also for understanding how brain development goes awry in neuropsychiatric disorders. For example, Shaw and coworkers[5] have used these techniques to show differences in cortical development between children with attention-deficit/hyperactivity disorder with better and worse outcome. They report that worse outcome is associated with thinning in prefrontal areas, whereas in children with better outcome, differences in parietal cortex normalize, possibly representing cortical compensation. Such work is permitting us to watch brain development in action and is helping us understand the neurobiology underlying these disorders.

However, the increase in the number of nontherapeutic magnetic resonance (MR) studies has sometimes led to concerns about ethical aspects of this work. For example, in the Netherlands, concerns have been raised about subject anxiety, and it has been questioned whether the procedure is not too traumatic for children younger than 12 years. MR simulation is one approach that can help to deal with subject anxiety: It is used at developmental imaging centers around the world to prepare children and their parents for MR studies. In response to the concerns in the Netherlands, we have worked closely with our institutional review board to develop protocolized MR simulation procedures (Fig. 1A). The purpose of simulation is to acquaint subjects and their parents with all aspects of the MR scanning session, to ensure the subject feels familiar with the researcher(s) present during MR scanning, to reduce anxiety associated with the MR scan, and to assess anxiety at the end of simulation so that the MR scan can be cancelled if necessary. The MR simulation mirrors all aspects of the MR scan: Subjects lie in the MR simulator and view cartoons through a mirror attached to the head coil, as they do in the scanner. The sounds for the MR sequences are played at the same volume as during scanning. The subjects and their parents are encouraged to ask questions and try out all aspects of the simulator. For young or particularly anxious children, we have a play tunnel and a toy animal available. The play tunnel has the same diameter as the MRI scanner and is used to introduce the concept of the tunnel. The toy animal has a relatively large head and can wear the headphones and participate in a play MR simulation. Finally, we have a Web site, where subjects can run a virtual simulation with a cartoon of the toy animal before they come into the laboratory (in Dutch: *www.niche-lab.nl*). In the course of MR simulation, we assess subject anxiety using visual analog scales. If anxiety exceeds a predetermined level after MR simulation, as assessed by the subject, their parent, or the researcher, the MR scan is cancelled. Anxiety is assessed three times: before MR simulation, after MR simulation, and after MR scanning.

In the last 3 years, 200 children have participated in MRI simulations in our laboratory. Of these, 45 children were diagnosed with attention-deficit/hyperactivity disorder, 64 with autism, and 91 were control subjects. Mean age was 10.1 years (SD 2.1 years), and mean IQ was 109 (SD 19). One hundred seventy-seven subjects were boys.

Only 3 of 200 MR scans were cancelled after simulation (1.5%). In all three cases, the researcher rated the subject as too anxious to continue with the scan. Repeated-measures analysis of variance on these data shows a linear decrease in anxiety levels with practice ($F_1 = 14.1$; $p < .001$; Fig. 1B). This shows that MR simulation is effective in reducing anxiety in children participating in MR studies. Anxiety ratings decrease as much for MR simulation as they do for the MR scan that follows it. This is in line with the subjective experience of many developmental neuroimagers, who report how useful simulators are for preparing children for MR scans.

Interestingly, children rated themselves as less anxious than they were rated by parents or researchers ($F_2 = 10.0$; $p = .002$; Fig. 1B). This may suggest that children tend to underreport their anxiety. As such, it illustrates the importance of getting ratings from multiple raters and suggests that the inclusion of another scale may be useful, in case a child does not want to admit to being anxious (we include

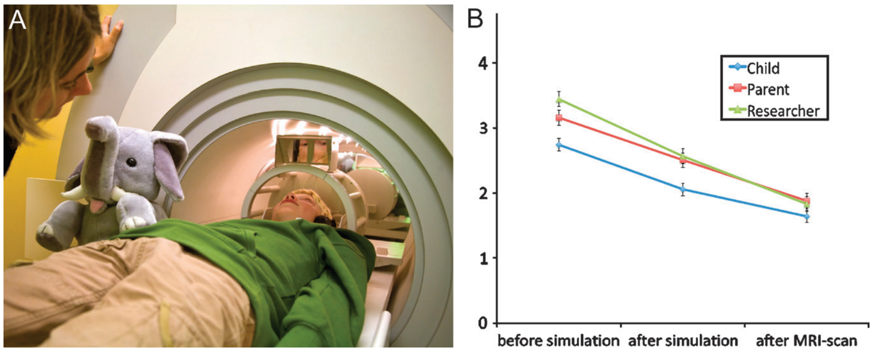

Fig. 1 A, The magnetic resonance simulator in our laboratory (photograph by Bob Bronshoff). B, The decrease in anxiety levels with practice (N = 200). Error bars represent SEs.

a "fun" scale to provide children with a second "opt out" option). Finally, there was no interaction between practice and diagnosis (F_2 = 0.48; p = .62). As such, the MR simulation procedures seem to work well for all diagnostic groups included here.

In summary, these data suggest that MR simulation is effective in reducing anxiety in children participating in MR research. As such, it is a useful tool for researchers using MRI to study human brain development in vivo.

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1. Casey BJ, Tottenham N, Liston C, Durston S. Imaging the developing brain: what have we learned about cognitive development? *Trends Cogn Sci*. 2005;9:104–110.
2. Durston S, Casey BJ. What have we learned about cognitive development from neuroimaging? *Neuropsychologia*. 2006;44:2149–2157.
3. Durston S, Hulshoff Pol HE, Casey BJ, Giedd JN, Buitelaar JK, van Engeland H. Anatomical MRI of the developing human brain: what have we learned? *J Am Acad Child Adolesc Psychiatry*. 2001;40:1012–1020.
4. Lenroot RK, Giedd JN. Brain development in children and adolescents: insights from anatomical magnetic resonance imaging. *Neurosci Biobehav Rev*. 2006;30:718–729.
5. Shaw P, Lerch J, et al. Longitudinal mapping of cortical thickness and clinical outcome in children and adolescents with attention-deficit/hyperactivity disorder. *Arch Gen Psychiatry*. 2006;63:540–549.

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