From 12 years onward you learn differently

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Eight-year-old children have a radically different learning strategy from twelve-year-olds and adults. Eight-year-olds learn primarily from positive feedback ('Well done!'), whereas negative feedback ('Got it wrong this time') scarcely causes any alarm bells to ring. Twelve-year-olds are better able to process negative feedback, and use it to learn from their mistakes. Adults do the same, but more efficiently.

The switch in learning strategy has been demonstrated in behavioural research, which shows that eight-year-olds respond disproportionately inaccurately to negative feedback. But the switch can also be seen in the brain, as developmental psychologist Dr Eveline Crone and her colleagues from the Leiden Brain and Cognition Lab discovered using fMRI research. The difference can be observed particularly in the areas of the brain responsible for cognitive control. These areas are located in the cerebral cortex.

In children of eight and nine, these areas of the brain react strongly to positive feedback and scarcely respond at all to negative feedback. But in children of 12 and 13, and also in adults, the opposite is the case. Their 'control centres' in the brain are more strongly activated by negative feedback and much less by positive feedback.

These research results are reported in *The Journal of Neuroscience* dated 17 September. Crone and her colleagues used fMRI research to compare the brains of three different age groups: children of eight to nine years, children of eleven to twelve years, and adults aged between 18 and 25 years. This three-way division had never been made before; the

comparison is generally made between children and adults.

Crone herself was surprised at the outcome: 'We had expected that the brains of eight-year-olds would function in exactly the same way as the brains of twelve-year-olds, but maybe not quite so well. Children learn the whole time, so this new knowledge can have major consequences for people wanting to teach children: how can you best relay instructions to eight- and twelve-year-olds?' '

The researchers gave children of both age groups and adults aged 18 to 25 a computer task while they lay in the MRI scanner. The task required them to discover rules. If they did this correctly, a tick appeared on the screen, otherwise a cross appeared. MRI scans showed which parts of the brain were activated.

These surprising results set Crone thinking. 'You start to think less in terms of 'good' and 'not so good'. Children of eight may well be able to learn extremely efficiently, only they do it in a different way.'

She is able to place her fMRI results within the existing knowledge about child development. 'From the literature, it appears that young children respond better to reward than to punishment.' She can also imagine how this comes about: 'The information that you have not done something well is more complicated than the information that you have done something well. Learning from mistakes is more complex than carrying on in the same way as before. You have to ask yourself what precisely went wrong and how it was possible.'

Is that difference between eight- and twelve-year-olds the result of experience, or does it have to do with the way the brain develops? As yet, nobody has the answer. 'This kind of brain research has only been possible for the last ten years or so,' says Crone, 'and there are a lot more questions which have to be answered. But it is probably a combination of

the brain maturing and experience.'

There is also an area of the brain that responds strongly to positive feedback: the basal ganglia, just outside the cerebral cortex. The activity of this area of the brain does not change. It remains active in all age groups: in adults, but also in children, both eight-year-olds and twelve-year-olds.

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