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A ''Turing Test'' and BCI for locked-in children and adults

Brain–computer interfaces (BCIs) have allowed paralyzed or locked-in patients to communicate (e.g. Lebedev and Nicolelis [1]). However, no successful BCI has been reported for children, perhaps because paradigms found to work for adults require a higher signal-to-noise ratio for neural activity than children's brains naturally produce. In addition, no successful BCI has been reported for patients who first encounter the BCI while locked-in: working systems have only been reported for patients with some movement or patients who began practicing with the system before becoming fully locked-in. The current proposal addresses both of these limitations of prior BCI systems.

Gomes et al. [2] report an auditory attention dichotic listening paradigm in which children as young as nine are asked to attend to high vs. low tones, with simultaneous streams of high and low tones including standard and discrepant exemplars of high and low tones within each stream (discrepant tones had either a different duration or loudness than standard tones). A strong mismatch negativity effect was revealed in EEG for discrepant tones compared to standard tones within the attended stream only. Therefore, the Gomes et al. procedure could be used as a BCI for children if based on the instruction to pay attention to the high tones to indicate ''yes'' or low tones to indicate ''no,'' for we would be able to infer to which tones the subject chose to attend. Similarly, Sanders et al. [3] report a dichotic listening experiment in which tones are embedded in simultaneously presented stories and the EEG response of children as young as three differs based on to which story the child attends. Neither of these methods required practice on the part of subjects in order to find discriminable EEG patterns between conditions. Even more straightforwardly, the words ''yes'' and ''no'' could be simultaneously presented to the left and right ears, respectively, with standard and discrepant exemplars of ''yes'' and ''no'' within each stream. This way, subjects could simply listen to the ''yeses'' to indicate ''yes'' and listen to the ''nos'' to indicate ''no''.

The hypothesis that these paradigms could produce a BCI for children is easily testable, requiring only a change in the task instructions (i.e. to selectively attend to indicate ''yes'' vs. ''no'' rather than to selectively attend to high vs. low tones or to one story vs. another). A sufficiently long string of correct ''yes'' vs. ''no'' answers to background questions can prove the reliability of the method. In addition, such a string of correct answers could prove that an entirely immobile individual (either child or adult) is, in fact, aware and in control of volition. Turing [4] proposed a test for consciousness in a computer: If a judge cannot differentiate between a computer's and a human's teletype responses to questions, it is reasonable to consider that the computer and the human are similarly sentient. A BCI procedure that requires no practice and can allow an entirely unmoving person to communicate can provide an analogous ''teletype'' mechanism and test for the presence of conscious thought in those for whom consciousness is otherwise in doubt.

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