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Human-Computer Interaction and Neuroscience: Science or Science Fiction?

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ABSTRACT

We present two neuroscience experiments that have major implications for HCI research: First, we discuss a functional Magnetic Resonance Imaging (fMRI) study by Sanfey et al. (2003) who investigated brain activities of players of the Ultimatum Game. It was found that participants had a stronger emotional reaction to unfair offers from humans than to the same offers from a computer. Second, we discuss a Positron Emission Topography (PET) study by Haier et al. (1992) who studied participants playing the computer game Tetris over a period of several weeks. It was found that learning may result in decreased use of extraneous or inefficient brain areas. Finally, we stress the importance of measuring theoretical constructs in HCI research (e.g. user satisfaction) by using neuroscience techniques. Since theoretical constructs are neither directly observable nor objectively measurable, we argue that recent achievements in neuroscience technology will allow for directly measuring feelings and thoughts (e.g. satisfaction) in the future.

Keywords

Neuroscience, user satisfaction, functional Magnetic Resonance Imaging (fMRI), Positron Emission Topography (PET)

ON IMPORTANT CONTENTS OF THE PRESENTATION

In a Positron Emission Topography (PET) study participants' brains were imaged at different points in time as they gained experience with the computer game Tetris (Haier et al. 1992, published in *Brain Research*, 570:1-2, 134-143). It was found that when participants began playing, they were highly aroused and many parts of the brain were active. As the participants got better at the game, overall blood flow at the brain decreased, and activity became localized in only a few brain regions. Participants who improved their Tetris performance the most after practice showed the largest glucose metabolic decreases after practice in several areas. These results suggest that learning may result in decreased use of extraneous or inefficient brain areas. Changes in regional subcortical glucose metabolic rate with practice may

reflect changes in cognitive strategy that are a part of the learning process.

In another study functional Magnetic Resonance Imaging (fMRI) was used to investigate brain activities of players of the Ultimatum Game (Sanfey et al. 2003, published in *Science*, 300, 1755-1758). In this game, two players are given the opportunity to split a sum of money (in their experiment \$10). One player is deemed the proposer (player 1) and the other one is the responder (player 2). Player 1 makes an offer as to how the money should be split between the two. Player 2 can either accept or reject the offer. If it is accepted, the money is split as proposed, but if player 2 rejects the offer, then neither player receives anything. In either event, the game is over. Sanfey et al. (2003) found that unfair offers of \$2 and \$1 made by human partners were rejected at a significantly higher rate than those offers made by a computer, suggesting that participants had a stronger emotional reaction to unfair offers from humans than to the same offers from a computer. Among the brain areas showing greater activation for unfair compared with fair offers from human partners were bilateral anterior insula, dorsolateral prefrontal cortex (DLPFC), and anterior cingulate cortex (ACC). The magnitude of activation was also significantly greater for unfair offers from human partners as compared to unfair offers from computer partners. This suggests that these activations were not solely a function of the amount of money offered to the participant but rather were also uniquely sensitive to the context, namely perceived unfair treatment from another human.

User satisfaction, for example, is among the most analyzed dependent variables in HCI research. User satisfaction is a theoretical construct and its existence has been postulated from survey studies. However, theoretical constructs are neither directly observable nor objectively measurable. Because of recent achievements in neuroscience technology, feelings and thoughts can be measured directly now. Since satisfaction is a feeling, it is likely that future research efforts will allow for directly measuring computer user satisfaction and similar constructs such as technology acceptance. We believe that HCI and Neuroscience is not a science fiction concept, rather, it is a new science.