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Motivation matters: Psychological models in brain-computer interfacing

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Introduction and Methods: To date, no theoretical models on the effect of motivation in brain-computer interfacing (BCI) do exist. Therefore, it is necessary to apply existing motivation theories to a BCI context. Within this theory transfer specifics need to be taken into account not only concerning the BCI user population (severely motor impaired individuals or healthy volunteers) and the BCI measurement situation (BCI study in the laboratory or a patient's home) but also the input signal which could be autonomously elicited like the P300 or controlled as a result of self-regulated learning (sensorimotor rhythm=SMR BCI). Thus, motivation models of self-regulated learning, like the adapted *Cognitive Model of Motivation* [1] seem applicable to the SMR BCI context, while Johnson's model of the P300 amplitude [2] might be useful in P300 BCI studies. Both could be influenced by the *Self-Determination Theory* [3] specifying the effect of motivation caused by reward (extrinsic motivation) and very likely playing a role in healthy volunteers. For motor impaired BCI users, on the other hand, motivation caused by performing a task per se (intrinsic motivation) and the need for competence and autonomy seem most applicable as presented in the *Cognitive Evaluation Theory* [4]. As a common basis for all BCI study participants there must be some valence of the outcome of BCI control, may it be intrinsic or extrinsic that together with expectancy of being able to control the system and the ability to do so might determine BCI performance. Therefore, Vroom's *Performance Model* [5] was chosen here as a basis of motivation influencing BCI performance while it was well acknowledged that other theories have an impact as well.

Results: As a first attempt to present a theoretical approach of the influence of motivation on BCI performance we present the motivation models including valence and expectancy for a P300 (MOTIVE-P300, see figure 1) and a SMR context (MOTIVE-SMR, see figure 2).

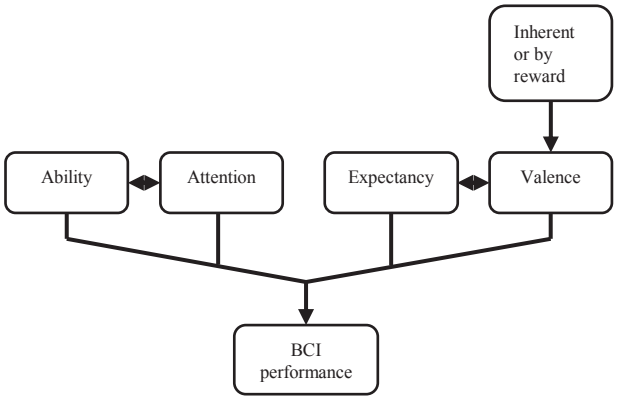

Figure 1. *MOTIVE –P300 model.*

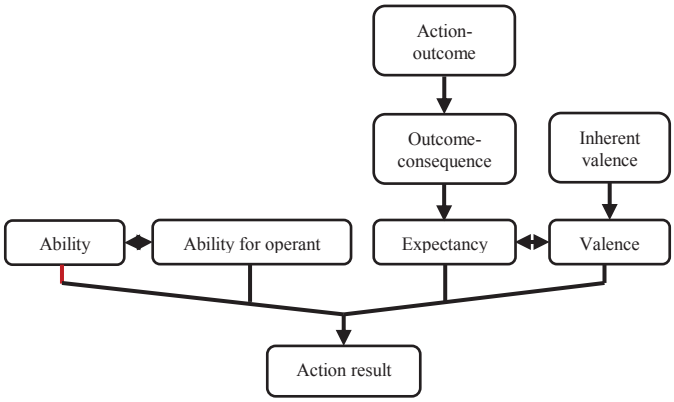

Figure 2. *MOTIVE –SMR model.*

Discussion: The here presented motivation models are based on existing BCI research results on the effect of motivation and on motivation theory. They need to be experimentally evaluated and their possible usefulness can only be judged thereafter.

Significance: If these models allow for variance explanation in BCI performance by identifying the role of motivation, they might bridge a gap between Psychology and BCI research and present a basis for further hypothesis testing.

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