

## The influence of stress and muscle fatigue on implicitly and explicitly learned motor skills

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According to Beek (2000), disturbing causes at the upper level of action (i.e. stress) and at the lower level of control (i.e. muscular fatigue) might result in different effects on performance when comparing implicit and explicit learning. In the present experiment an errorless/errorfull learning paradigm was used to enable the implicit/explicit acquisition of a dart throwing skill. After a pretest, the errorfull group (N=23) threw from a progressively decreasing distance (from 317 to 257 cm), while the inverse procedure was used for the errorless group (N=21) (from 157 to 217 cm). One week after the four-day learning period (400 trials) both groups performed a transfer test, a fatigue test and a stress test (all from 237 cm). The fatigue test was preceded by a double Wingate protocol on an arm crank ergometer. At the beginning of the stress test participants were told they could win a significant financial reward in case of a good performance. Retrospective self-report of nervousness was administered under stressed and unstressed conditions. Hitting accuracy of the errorfull group improved from M=5.29 (maximum=15) in the first learning block to M=7.81 in the final learning block, while the errorless group evolved from M=9.67 to M=8.74, which is typical for an errorless/errorfull learning paradigm. In comparison to the scores at the pre-test both groups performed equally (performance increase of 22%) at the transfer test. Performance of both groups decreased at the fatigue test, but this decrease was much less in the explicit group (5%, *ns*) as compared to the implicit group (18%,  $p < .005$ ). Stress manipulation resulted in an increase of self-reported nervousness; however stress did not have a differential impact on performance in both groups. Our results of the fatigue test confirmed the hypothesis of robustness of explicit motor learning to physiological fatigue, meaning that success depends on the person's ability to circumvent the (temporary) impairment induced by muscular fatigue, and thus develop alternative strategies based upon explicit knowledge. The contradiction with the findings of Poolton et al. (2006) may be due to task specificity and the sort of fatigue induced (local vs. global), which calls for further research on this topic. Our results of the stress test do not show the superiority of implicit or explicit learning when performing under stress.

### Key References

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