Can experience in karate be estimated by Principal Component Analysis?

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Karate is a Japanese martial art that involves repeated and technically demanding sequences of strikes and defences. In kata competition selected movements are organised in fixed sequences of varying duration and complexity. The evaluation of kata is usually made by subjective scoring from coaches and judges, who employ a qualitative, global assessment. Holistic quantitative evaluations of karate performance are still unavailable. Based on previous findings (1), we hypothesise that the multi-joint motion patterns that enable complex techniques are experience-dependent. If this were true, we would seek to find which motion pattern could be more sensible to the experience level. To test this hypothesis, a method based on the Principal Component Analysis (PCA) appears well-suited to detect the "synergies" or "coordinative structures" by which the motor system organises a movement (2). PCA can provide a quantitative global analysis of stylistic differences in technique. In this study we aimed at: describing the fundamental multi-joint synergies of a karate performance, under the hypothesis that the latter are skill-dependent; estimate karateka's experience level, expressed as years of practice. A motion capture system recorded traditional karate techniques of ten professional and amateur karateka. At any time point, the 3D-coordinates of body markers gave posture vector that were normalised, concatenated from all karateka and submitted to a first PCA. Five principal movements described both gross movement synergies and individual difference, explaining 91% of the overall variance. A second PCA followed by linear regression estimated the years of practice using principal movements (eigenpostures and weighting curves) and centre-of-mass kinematics (error: 3.71 ys; $R^2=0.91$, $p<0.001$). Principal movements and eigenpostures varied among different karateka and as a function of experience. This approach provides a framework to develop visual tools for the analysis of motor synergies in karate, allowing to detect the multi-joint motor patterns that should be specifically trained to increase performance.

References

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