Implication of subjective perception of the task on Procedural Perceptual-Motor Learning in typical development : a study on children from 6 to 10 years old and adults

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Résumé

Introduction: Procedural Perceptual-Motor Learning (PPML) enables the acquisition of new motor procedures, allowing individuals to respond effectively to environmental constraints. It involves two sub-processes: motor sequence learning and sensorimotor adaptation (Doyon & Benali, 2005). While some studies suggest that PPML develops with age, findings remain debated (Zwart et al., 2019). To address these discrepancies, it is crucial to consider not only age and motor level but also the subjective perception of the task – that is, how learners perceive and engage with it (Wulf & Lewthwaite, 2016). This subjective perception encompasses explicit knowledge (knowledge of task regularities), metacognitive judgment (perceived progress) and the subjective evaluation of ones' internal state. This study investigates the implication of these factors in both PPML sub-processes, while also considering the influence of age and motor level.
Methods: 220 children (ages 6-10 years) and 34 adults (ages 18-32 years) participated in this study. Participants first completed a BHK task (Charles et al., 2004) to assess motor level through the speed and quality of handwriting. Subsequently, they completed two tasks designed to assess PPML: a Serial Reaction Time Task (SRTT) for motor sequence learning and a Target Jumping Task (TJT) for sensorimotor adaptation. Each task comprised different learning phases: repeated blocks (involving repeated sequence or jump) and an interference block (involving variation of task parameters). Following the completion of each task, participants responded to questions assessing their explicit knowledge (sequence or repeated jump perception), metacognitive judgement (perceived progress) and subjective evaluation (perceived stress, motivation and tiredness). For analyses, participants were categorized into three groups for each task based on their reported level of explicit knowledge ("yes", "no", "don't know"). Learning scores were computed as the difference in performance between learning blocks. For each task (SRTT and TJT), learning scores were compared between groups using Analyses of Covariance (ANCOVAs) with age and BHK scores as covariates. Spearman correlations were conducted to assess the associations between learning scores and the scores of metacognitive judgment, perceived stress, motivation and tiredness.

*Intervenant

Results: For SRTT, ANCOVAs revealed that, compared to the group without explicit knowledge, the group with explicit knowledge exhibited significantly lower general sequence learning but had significantly greater resistance to interference. The covariable BHK score had a significant effect on the general learning score. For TJT, ANCOVAs revealed that, compared to the two groups without explicit knowledge, the group with explicit knowledge showed significantly lower retention of the jump following the interference block. Spearman correlations revealed that SRTT learning scores were associated with both metacognitive judgment and motivation scores, while TJT learning scores were associated with metacognitive judgment only.

Discussion: Explicit knowledge has a positive effect on motor sequence learning (SRTT) and a negative effect on sensorimotor adaptation (TJT), with no significant association with age. This dissociation is consistent with previous findings in adults (Seiwert et al., 2025). For motor sequence learning, learning is associated with both the motor level and the subjective evaluation of internal state. For both tasks, learning scores is associated with metacognitive judgment. These findings underscore the significant role of individual motor level and task perception on PPML, emphasizing the necessity of considering both motor and subjective factors when assessing motor learning processes across development. Our results also provide perspectives regarding atypical development, particularly for children with neurodevelopmental disorders who present motor deficits and potentially altered subjective perception of the task.

References:

Charles, M., Soppelsa, R., & Albaret, J. M. (2004). BHK: échelle d'évaluation rapide de l'écriture chez l'enfant. Ecpa.

Doyon, J., & Benali, H. (2005). Reorganization and plasticity in the adult brain during learning of motor skills. *Current Opinion in Neurobiology*, *15*(2), 161-167.

Seiwert, S., Martin, E., Lagarrigue, Y., Amarantini, D., Fautrelle, L., Tisseyre, J., & Tallet, J. (2025). Implication of explicit knowledge and subjective evaluation in procedural perceptual-motor learning. *Frontiers in Behavioral Neuroscience*, *19*, 1567905.

Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review*, *23*(5), 1382-1414.

Zwart, F. S., Vissers, C. Th. W. M., Kessels, R. P. C., & Maes, J. H. R. (2019). Procedural learning across the lifespan: A systematic review with implications for atypical development. *Journal of Neuropsychology*, *13*(2), 149-182.