Maximization of the Child's Success

This section will include literature from the field of motor learning, regarding feedback from performance and literature from the field of psychology/learning regarding scaffolding for successful performance and engagement. We will also include relevant literature on self esteem and how to best foster it.

2009

Savion-Lemieux T, Bailey JA, Penhune VB. (2009). Developmental contributions to motor sequence learning. Exp Brain Res. 2009 May;195(2):293-306. Epub 2009 Apr 11.

Little is known about how children acquire new motor sequences. In particular, it is not clear if the same learning progression observed in adults is also present in childhood nor whether motor skills are acquired in a similar fashion across development. In the present study we used the multi-finger sequencing task (MFST), a variant of the serial reaction time (SRT) task, to study motor sequence learning, across two consecutive days, in three cross-sectional samples of children aged 6, 8, and 10 years, and a control sample of adults. In the MFST, participants reproduced 10-element sequences of key presses on an electronic keyboard, using four fingers of the right hand. Each block of practice included 10 intermixed trials of a Repeated (REP) sequence and four trials of Random (RAN) sequences. Performance was assessed by examining changes in accuracy, a component of the task that requires the association of the visual stimulus with the motor response, and response synchronization, a component that requires fine-grained sensorimotor integration and timing. Additionally, participants completed Recognition and Recall tests, to assess explicit knowledge of the repeated sequence. Overall, results showed a developmental progression in motor sequence learning within and across days of practice. Interestingly, the two behavioral measures showed different developmental trajectories. For accuracy, differences were greatest for the two youngest groups early in learning, and these groups also showed the greatest rate of improvement. However, by the end of Day 2, only the 6-year-olds still lagged behind all other groups. For response synchronization, all child groups differed from adults early in learning, but both child and adult groups showed similar rates of improvement across blocks of practice. By the end of Day 2, 10-year-olds reached adult levels of performance, whereas 6- and 8-year-olds did not. Taken

together, the dissociation observed with our two behavioral measures of sequence learning is consistent with the hypothesis that accuracy or finger-stimulus association may rely on cortical pathways that show the greatest maturation between ages 6 and 10; whereas motor timing and sensorimotor integration may rely on subcortical pathways that continue to develop into young adulthood. Despite developmental differences across blocks of practice on both behavioral measures, there were no significant group differences for either the Recognition or Recall tests. We suggest that explicit knowledge of the MFST is not directly linked to task performance, thus challenging the implicit-explicit distinction in pediatric SRT studies assessing the developmental invariance model.

Ford P, Hodges NJ, Mark Williams A. (2009). An evaluation of end-point trajectory planning during skilled kicking. Motor Control. 13(1):1-24.

There is evidence that actions are planned by anticipation of their external effects, with the strength of this effect being dependent on the amount of prior practice. In Experiment 1, skilled soccer players performed a kicking task under four conditions: planning in terms of an external action effect (i.e., ball trajectory) or in terms of body movements, either with or without visual error feedback. When feedback was withheld, a ball focus resulted in more accurate outcomes than a body focus. When visual feedback was allowed, there was no difference between these two conditions. In Experiment 2, both skilled and novice soccer players were tested with the addition of a control condition and in the absence of visual feedback. For both groups there was evidence that a ball focus was more beneficial for performance than a body focus, particularly in terms of movement kinematics where correlations across the joints were generally higher for body rather than ball planning. Most skilled participants reported that ball planning felt more normal than body planning. These experiments provide some evidence that actions are planned in terms of their external action effects, supporting the common-coding hypothesis of action planning.

Gilmore L, Cuskelly M. (2009). A longitudinal study of motivation and competence in children with Down syndrome: early childhood to early adolescence. J Intellect Disabil Res. 2009 May;53(5):484-92. Epub 2008 Mar 19.

BACKGROUND: Motivation has been identified as an area of difficulty for children with Down syndrome. Although individual differences in mastery motivation are presumed to have implications for subsequent competence, few longitudinal studies have addressed the stability of motivation and the predictive validity of early measures for later academic achievement, especially in atypical populations. METHOD: The participants were 25 children with Down syndrome. Mastery motivation, operationalized as persistence, was measured in early childhood and adolescence using tasks and parent report. At the older age, preference for challenge, another aspect of mastery motivation, was also measured and the children completed assessments of academic competence. RESULTS: There were significant concurrent correlations among measures of persistence at both ages, and early task persistence was associated with later persistence. Persistence in early childhood was related to academic competence in adolescence, even when the effects of cognitive ability at the younger age were controlled. CONCLUSIONS: For children with Down syndrome, persistence appears to be an individual characteristic that is relatively stable from early childhood to early adolescence. The finding that early mastery motivation is significant for later achievement has important implications for the focus of early interventions.

Robinson LE, Goodway JD. (2009). Instructional climates in preschool children who are at-risk. Part I: object-control skill development. Res Q Exerc Sport. 80(3):533-42.

Part I of this study examined the effect of two 9-week instructional climates (low autonomy [LA] and mastery motivational climate [MMC]) on object-control (OC) skill development in preschoolers (N = 117). Participants were randomly assigned to an LA, MMC, or comparison group. OC skills were assessed at pretest, posttest, and retention test with the Test of Gross Motor Development-2nd Edition. A significant Treatment x Time interaction ($p < .001$) was present, supporting the effectiveness of both OC instructional climates in improving OC skills over time, while the comparison group resulted in no changes. The

authors conclude that developmentally and instructionally appropriate climates are beneficial to OC skill learning, along with the need for "planned" movement experiences in motor learning environments.

Prior to 2009

Engel, A., Burke, M., Fiehler, K., Bien, S., & Rösler, F. (2008). Motor learning affects visual movement perception ***European Journal of Neuroscience*****, *27* , 2294-2302.**

In the present study we investigated whether imitation of artificial movement trajectories of meaningless objects has an effect on how these trajectories are later perceptually processed within the human brain. During observation of a sequence of artificial object movements 10 participants (experimental group) actively imitated the trajectories during motor training and 10 participants (control group) solved a working memory task without motor training. The haemodynamic responses were recorded before and after the intervention while participants observed the movements and either had to detect colour changes of one of the objects (colour task, motor-irrelevant) or had to judge whether the movement pattern could be imitated with the hands (simulation judgement task, motor-relevant). The between-group comparison of the post-intervention haemodynamic responses revealed stronger activity for the motor training than for the control group during the simulation judgement task. This activity appeared in motor-related areas (supplementary motor area and inferior parietal lobe) and in the occipito-temporal area. During the colour task, the motor training group showed stronger activity in the occipital lobe. The control group did not reveal any stronger activity than the motor training group for either task. The results suggest that motor training has task-specific effects on neural processes that are involved in perception of movements. Furthermore, they indicate that motor-related areas are triggered by observed artificial object movements, but only if a motor-relevant task is pursued.

Keetch KM, Lee TD.(2007). The effect of self-regulated and experimenter-imposed practice schedules on motor learning for tasks of varying difficulty. ***Research Quarterly on Exercise and Sport*****, *78*, 476-86.**

Research suggests that allowing individuals to control their own practice schedule has a positive effect on motor learning. In this experiment we examined the effect of task difficulty and self-regulated practice strategies on motor learning. The task was to move a mouse-operated cursor through pattern arrays that differed in two levels of difficulty. Participants learned either four easy or hard patterns after assignment to one of four groups that ordered practice in blocked, random, self-regulated, and yoked-to-self-regulated schedules. Although self-regulation provided no special benefit in acquisition, these groups showed the most improved performance in retention, irrespective of task difficulty. Although individual switch strategies for members of the self-regulated groups were quite variable, the impact of self-regulation on motor learning remained similar. These findings add to the growing body of literature suggesting that self-regulated practice is an important variable for motor learning.

Ford, P., Hodges, N.J., & Williams, A. M.(2007). Examining action effects in the execution of a skilled soccer kick by using erroneous feedback. ***Journal of Motor Behavior*****, *39*, 481-90.**

The authors examined the role of action effects (i.e., ball trajectory) during the performance of a soccer kick. Participants were 20 expert players who kicked a ball over a height barrier toward a ground-level target. The authors occluded participants' vision of the ball trajectory after foot-to-ball contact. Participants in a 1st group received erroneous feedback from a video that showed a ball-trajectory apex approximately 75 cm lower than that of their actual kick, although the ball's landing position was unaltered. Participants in a 2nd group received correct video feedback of both the ball trajectory and the landing position. The erroneous-feedback group showed a significant bias toward higher ball trajectories than did the correct-feedback group. The authors conclude that performers at high levels of skill use the visual consequences of the action to plan and execute an action.

Emanuel, M., Jarus, T., & Bart, O. (2008). Effect of focus of attention and age on motor acquisition, retention, and transfer: a randomized trial. *Physical Therapy*, *88*, 251-60.

BACKGROUND AND PURPOSE: Adult participants benefit more from external focus than internal focus when learning a new motor skill. Because learners from different age groups use different learning strategies, the purpose of this study was to investigate whether the effect of attention focus varies among children and adults. SUBJECTS AND METHODS: Thirty-four children and 32 adults were randomly assigned to internal or external focus-of-attention practice groups. Throwing darts toward a static target, participants performed 50 acquisition trials, 20 retention trials, and 20 transfer trials. RESULTS: The results indicate that focus of attention varies between children and adults in accuracy and variability in the acquisition phase and in accuracy in the transfer phase. No interactions were found in the retention phase. DISCUSSION AND CONCLUSION: The findings suggest that external focus is more effective than internal focus in adults; therefore, physical therapists should instruct adult clients to focus their attention externally to facilitate motor learning. Physical therapists working with children should perhaps direct the client's attention internally; however, further study is needed.

Hayes, S.J., Ashford, D., & Bennett S.J. (2008). Goal-directed imitation: the means to an end. *Acta Psychologica*, *127*, 407-15.

The effects of goal-directed imitation and observational learning were examined whilst learning a goal-directed motor skill (three-ball cascade juggling). An observational learning (OL) group observed a model and a control (CON) group received minimal verbal instructions regarding how to hold and release the juggling balls. The OL group performed more juggling cycles across practice and retention than the CON group. In addition, the OL group's upper limb coordination and ball flight trajectory pattern were more similar to the model's movements than the CON group. These data show that when the to-be-learnt movement pattern and end-goal are not specified by the task's mechanical constraints, or can be achieved by modifying a pre-existing motor skill, individuals have difficulty learning on the basis of discovery processes alone. Under these circumstances, observational learning is effective because it conveys to the individual the specific means by which the end-goal can be achieved. These findings lead us to suggest that when the end-goal and the means to achieve the end-goal are directly linked,

the means are given sufficient weight in the goal hierarchy such that the model's movement is imitated.

Fine, M.S., & Thoroughman, K.A. (2007). Trial-by-trial transformation of error into sensorimotor adaptation changes with environmental dynamics. *Journal of Neurophysiology*, *98*,1392-404.

Humans can rapidly change their motor output to make goal-directed reaching movements in a new environment. Theories that describe this adaptive process have long presumed that adaptive steps scale proportionally with error. Here we show that while performing a novel reaching task, participants did not adopt a fixed learning rule, but instead modified their adaptive response based on the statistical properties of the movement environment. We found that as the directional bias of the force distribution shifted from strongly biased to unbiased, participants transitioned from an adaptive process that scaled proportionally with error to one that adapted to the direction, but not magnitude, of error. Participants also modified their response as the likelihood of the perturbation changed; as the likelihood decreased from 80 to 20% of trials, participants adopted an increasingly disproportional strategy. We propose that people can rapidly switch between learning processes within minutes of experiencing a novel environment.

Wills, A.J., Lavric, A., Croft, G.S., & Hodgson, T.L. (2007). Predictive learning, prediction errors, and attention: evidence from event-related potentials and eye tracking. *Journal of Cognitive Neuroscience*, *19*, 843-54.

Prediction error ("surprise") affects the rate of learning: We learn more rapidly about cues for which we initially make incorrect predictions than cues for which our initial predictions are correct. The current studies employ electrophysiological measures to reveal early attentional differentiation of events that differ in their previous involvement in errors of predictive judgment. Error-related events attract more attention, as evidenced by features of event-related scalp potentials previously implicated in selective visual attention (selection negativity, augmented anterior N1). The earliest differences detected occurred around 120 msec after stimulus onset, and distributed source localization (LORETA) indicated that the inferior temporal regions were

one source of the earliest differences. In addition, stimuli associated with the production of prediction errors show higher dwell times in an eye-tracking procedure. Our data support the view that early attentional processes play a role in human associative learning.

Granados, C. & Wulf, G.(2007). Enhancing motor learning through dyad practice: contributions of observation and dialogue. *Research Quarterly on Exercise and Sport*, *78*, 197-203.

It has been shown that practice in dyads, as compared to individual practice, can enhance motor learning and increase the efficiency of practice (as two participants can be trained at the same time; Shea, Wulf, & Whitacre, 1999). The dyad practice protocol used by Shea et al. included both observation and dialogue between partners. Thus, it was not clear whether the learning benefits of dyad practice were due to observation, dialogue, or both. The present study examined the individual and interactive effects of observation and dialogue. The task used was speed cup stacking. Participants practiced under one of four conditions: observation/dialogue, observation/no dialogue, no observation/dialogue, and no observation/no dialogue. The two conditions that included observational practice were more effective (i.e., produced faster movement times) than the two conditions without it, both during practice and on a retention test performed under individual performance conditions. This suggests that the learning advantages of dyad practice are primarily due to the opportunity to observe another learner.

Horn, R.R., Williams, A.M., Hayes, S.J., Hodges, N.J., & Scott, M.A. (2007). Demonstration as a rate enhancer to changes in coordination during early skill acquisition. *Journal of Sports Science*, *25*, 599-614.

We compared the nature and rate of change in intra-limb coordination in participants who observed a video model (model) with those who practised based on verbal guidance only (control). Sixteen male novices threw a ball towards a target with maximal velocity using a back-handed, reverse baseball pitch. Participants in the model group immediately changed their intra-limb relative motion to more closely resemble the model's relative motion pattern. This new coordination

pattern, and concomitant changes in ball speed, was maintained throughout acquisition, without further change. In contrast, the control group showed no change in coordination or ball speed across acquisition. Our findings suggest that demonstrations act as a rate enhancer, conveying an immediate movement solution that is adopted early in acquisition. A model may constrain the learner to perceive and imitate the model's relative motion pattern as suggested by Scully and Newell (1985). The stability of this new movement pattern questions accounts of learning, which suggest that prescriptive, directed learning may result in the "soft assembly" of an inaccurate and temporary movement solution.

Mullen, R., Hardy, L., & Oldham, A. (2007). Implicit and explicit control of motor actions: revisiting some early evidence. *British Journal of Psychology*, *98*, 141-56.

Two studies have questioned Masters' (1992) contention that skills acquired in implicit practice conditions are less likely to fail under pressure than those acquired explicitly. The studies produced conflicting results. The aim of the present study was to revisit the designs of both studies in an attempt to clarify the situation. Thirty-two participants were allocated to one of three separate implicit training groups or an explicit training group, and practised putting golf balls. Participants were exposed to an anxiety intervention at two points during practice. Putting performance across practice and anxiety phases were analysed using the number of putts successfully completed as the main dependent variable. We found further evidence for the suggestion that motor skills are robust under pressure when acquired in implicit practice conditions.

Mackrous I, & Proteau L. (2007). Specificity of practice results from differences in movement planning strategies. *Experimental Brain Research*,*183*, 181-193.

Withdrawing visual feedback after practice of a manual aiming task results in a severe decrease in aiming accuracy. This decrease in accuracy is such that participants are often less accurate than controls who are beginning practice of the task without visual feedback. These results have been interpreted as evidence that motor learning is specific to the sources of afferent information optimizing performance, because it could be processed at the exclusion of other sources of afferent

information. The goal of the present study was to test this hypothesis. To reach our goal we evaluated whether online visual feedback prevented kinesthetic information to be used for: (1) eliminating movement anisotropy resulting from difference in limb inertia when aiming in different directions and (2) creating an internal model of limb mechanics. Participants practiced a manual aiming task with or without visual feedback and with knowledge of results. After this acquisition phase, participants performed two transfer tests. The first transfer test was performed without visual feedback and/or knowledge of results. The second transfer test was similar to the first one but participants initiated their movements from a different starting base. The results showed strong specificity effects in that withdrawing visual feedback resulted in large pointing bias and variability. However, the results of the two transfer tests showed that the processing of visual feedback did not prevent the processing of kinesthetic information used to eliminate movement anisotropy or to create an internal model of limb mechanics. Rather, specificity of practice effects resulted from participants using the same motor plan in transfer as they did in acquisition even though they had no longer access to visual feedback to modulate their movement online. These results indicate that during acquisition participants adopted different movement planning strategies depending on the source of afferent information available.

Tzetzis G, Votsis E. (2006). Three feedback methods in acquisition and retention of badminton skills. *Perceptual and Motor Skills*, *102*, 275-84.

Comparison of three different feedback methods using information about the correct execution of the technique, errors of execution, and a combination of these on the acquisition and retention of two badminton skills of different difficulty were examined. Participants were 48 young male athletes, 10 to 14 years of age, with 2 to 4 years of training. They were divided into three equal groups and instructed on the long forehand serve, a more difficult serve than the short backhand. The first group received instructions for correct execution, the second group received instructional cues on errors of execution, and the third group received instructions on errors and how to correct them. The training program lasted 12 practice units. There was a pretest, a posttest after the end of the 10-wk. training program, and 2 wk. later, a retention test. A three-way (2 difficulty x 3 groups x 3 measures) analysis of variance with repeated measures on the last factor was applied to analyze scores with the three practice methods of corrective feedback for the two badminton skills. Analysis showed the group receiving

correct technique information had increased scores on both skills. The group receiving information on errors increased their scores on the less difficult skill. The group receiving information on errors and correct technique increased their scores on the more difficult skill. Physical education teachers or coaches teaching skills to young participants should consider difficulty of skills and use appropriate corrective feedback for better acquisition and retention of sport skills.

Wilde H, Magnuson C, & Shea CH. (2005). Random and blocked practice of movement sequences: differential effects on response structure and movement speed. *Research Quarterly on Exercise and Sport*, *76*, 416-25.

Three similar six-element key press sequences were practiced under blocked or random practice schedules with acquisition conducted on one day and retention and transfer on the next day. The task required participants to type, as quickly as possible, one of three 6-element sequences as observed on a computer monitor. In blocked practice, participants completed all practice in one repeated sequence before the next repeated sequence was introduced. In random acquisition practice, the three repeated sequences were randomly presented to the participants. The data suggest that random practice results in participants adopting a uniform response structure, while blocked practice allows participants to exploit unique sequential aspects of the individual tasks. This finding suggests that random practice may not be as effective as blocked practice when one of the tasks being practiced together can be optimized through the development of a unique response structure.

Tjernström F, Fransson PA, & Magnusson M. (2005). Improved postural control through repetition and consolidation. *Journal of Vestibular Research*, *15*,31-9.

Research regarding the optimal frequency of training in postural control rehabilitation has been sparse. Posturography with vibratory proprioceptive stimulation was performed with eyes open and closed on 36 healthy subjects divided into 3 groups. Each group was tested 5 times, though with different time-intervals; 20 minutes, 3 hours and 24 hours respectively. Two different adaptive processes seems to be involved in the formation of a new movement pattern when exposed to a postural disturbance, one fast adaptation active during each test

occasion and a second adaptation active between the consecutive tests. As the same adaptation pattern was found regardless the repetition time interval, the results imply either that the consolidation process of the new motor memory is time-independent or that the stimulus was sufficiently strong to induce fast consolidation thus leaving the time-interval unimportant. The findings suggest that it is primarily the number of repetitions in the exercises that governs the outcome of training, whereas the time interval between the exercises is of less importance.

Hodges NJ, Franks IM. (2002). Modelling coaching practice: the role of instruction and demonstration. *Journal of Sports Science*, *20*, 793-811.

In this paper, we review the empirical literature pertaining to the effectiveness of instructions and movement demonstrations. Initially, we examine existing theories and approaches that try to explain the process of skill acquisition so as to determine implications of these theories for instructional provision. This is followed by an evaluation of studies in the motor learning literature in which pre-practice information has been manipulated. Explicit learning strategies are contrasted to implicit and discovery learning methods, and current explanations for instructional effects are discussed in terms of such mechanisms as effects-related attentional focus and movement variability. In the final sections, we review data from our own laboratory where pre-practice information has been manipulated during the learning of a novel bimanual coordination task. From these studies, proposals are made to try and explain how pre-practice information works to effect the process of skill acquisition, including the selection and execution of a response and the processing of associated feedback. An important role is given to the existing skills of the learner in understanding the instructions and performing the desired movement. Finally, we suggest some practical implications of this empirical evidence for the teaching of motor skills.

Al-Abood SA, Davids KF, & Bennett SJ.(2001). Specificity of task constraints and effects of visual demonstrations and verbal instructions in directing learners' search during skill acquisition. *Journal of Motor Behavior*, *33*, 295-305.

In the present study, the efficacy of visual demonstrations and verbal instructions as instructional constraints on the acquisition of movement coordination was investigated. Fifteen participants performed an aiming task on 100 acquisition and 20 retention trials, under 1 of 3 conditions: a

modeling group (MG), a verbally directed group (VDG), and a control group (CG). The MG observed a model intermittently throughout acquisition, whereas the VDG was verbally instructed to use the model's movement pattern. Participants in the CG received neither form of instruction. Kinematic analysis revealed that compared with verbal instructions or no instructions, visual demonstrations significantly improved participants' approximation of the model's coordination pattern. No differences were found in movement outcomes. Coordination data supported the visual perception perspective on observational learning, whereas outcome data suggested that the modeling effect is mainly a function of task constraints, that is, the novelty of a movement pattern.

Wulf G, Shea C, & Park JH. (2001). Attention and motor performance: preferences for and advantages of an external focus. *Research Quarterly on Exercise and Sport*, *72*, 335-44.

This study examined individuad differences in the preference for and effectiveness of the type of attentional focus for motor learning. In two experiments, participants practicing a balance task (stabilometer) were asked to find out whether focusing on their feet (internal focus) or on two markets in front of their feet (external focus) was more effective. In Experiment 1, participants switched their attentional focus from trial to trial on Day 1 and used their preferred attentional focus on Day 2. In Experiment 2, participants were free to switch their attentional focus any time during 2 days of practice. Retention tests were performed on Day 3. Most participants chose an external focus. Also, they were more effective in retention than participants who preferred an internal focus.

Wulf G, McNevin N, & Shea CH. (2001). The automaticity of complex motor skill learning as a function of attentional focus. Quarterly Journal of Experimental Psychology A, 54, 1143-54.

The present experiment was designed to test the predictions of the constrained-action hypothesis. This hypothesis proposes that when performers utilize an internal focus of attention (focus on their movements) they may actually constrain or interfere with automatic

control processes that would normally regulate the movement, whereas an external focus of attention (focus on the movement effect) allows the motor system to more naturally self-organize. To test this hypothesis, a dynamic balance task (stabilometer) was used with participants instructed to adopt either an internal or external focus of attention. Consistent with earlier experiments, the external focus group produced generally smaller balance errors than did the internal focus group and responded at a higher frequency indicating higher confluence between voluntary and reflexive mechanisms. In addition, probe reaction times (RTs) were taken as a measure of the attention demands required under the two attentional focus conditions. Consistent with the hypothesis, the external focus participants demonstrated lower probe RTs than did the internal focus participants, indicating a higher degree of automaticity and less conscious interference in the control processes associated with the balance task.

Mount J. (1987). Effectiveness of visual vs kinesthetic instruction for learning a gross motor skill. *Perceptual & Motor Skills*, *65*, 715-20.

The purpose of this study was to compare visual with kinesthetic instruction for learning a motor skill that is not visually monitorable. Previous studies comparing visual and kinesthetic information have all used arm tasks for which the nonvisual condition was artificial. 20 subjects were randomly assigned to either a kinesthetic or a visual instruction group. The task was to draw a horizontal line with the right foot while in a quadruped position. All subjects received visual knowledge of results. While performance improved over the course of the 10 instructional sessions and trials, no difference in performance was found between the two instructional groups. A follow-up study is required to determine whether this result was based on visual dominance. Understanding the effectiveness of the different modalities for teaching gross motor skills would be valuable to physical therapists, physical educators, and psychologists.