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LITERATURE REVIEW

# THE IMPACT OF ATTENTIONAL FOCUS ON THE TREATMENT OF MUSCULOSKELETAL AND MOVEMENT DISORDERS

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## ABSTRACT

Treatment plans employed by physical therapists involved in musculoskeletal rehabilitation may follow a conventional medical-model approach, isolating care at the tissue level but neglecting consideration for neurocognitive contributions to recovery. Understanding and integration of motor learning concepts into physical therapy practice is integral for influencing the human movement system in the most effective manner. One such motor learning concept is the use of verbal instruction to influence the attentional focus of the learner. Evidence suggests that encouraging an external focus of attention through verbal instruction promotes superior motor performance, and more lasting effects of a learning experience than an internal focus of attention. Utilizing an external focus of attention when instructing a patient on a motor task may facilitate improved motor performance and improved functional outcomes in treatment plans devised to address musculoskeletal injury and movement disorders. The purpose of this review is to summarize the basic principles of motor learning and available evidence on the influence an external focus of attention has on motor learning and performance, including the benefits of an external focus of attention over an internal focus of attention and how therapists may inadvertently encourage the latter. Furthermore, the benefits of possessing greater awareness of neurocognitive mechanisms are discussed to exhibit how implementing such concepts into musculoskeletal rehabilitation can maximize treatment outcomes.

***Level of Evidence:*** 5

***Key Words:*** Focus of attention, motor learning, movement system, musculoskeletal rehabilitation

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## INTRODUCTION

One of the foundations of the physical therapy profession is the understanding and rehabilitation of human movement.[1,2] Over the past several decades, many clinicians and academics have expanded the profession's base of knowledge and understanding of the human movement system and advanced recognition of physical therapists' role as movement impairment specialists of choice.[2-5] In 1975, Hislop[5] proposed pathokinesiology, the study of anatomy and physiology pertaining to abnormal human movement, as the foundational science of our profession. In 2014, Sahrmann[2] broadened this view to involve consideration of conditions caused by "imprecise or insufficient movement" or, kinesiopathology. The Physical Therapy profession's evolving identity is best exemplified by the vision statement adopted by the American Physical Therapy House of Delegates, which has charged the profession with "transforming society by optimizing movement to improve the human experience."[1]

Given this framework, a paradox arises in clinical practice when a conventional medical-model, focused on the remediation of localized disease and injury, is heavily relied upon during treatment efforts. As a large component of musculoskeletal rehabilitation involves promoting motor control and skill acquisition, this conventional approach may overlook key elements of motor learning. Specifically, less focus may be given to neurocognitive functions, which contribute to the successful teaching and learning of efficient movement.[6]

A therapist's instructions are a crucial consideration in teaching motor skills and directing a learner's attention of focus. Awareness of the quality of instructions, how they are employed and what significance they have to the learning process, may greatly influence the rate at which a skill is learned and how well the learner retains it. This may also be largely influenced by the individual's attention of focus when learning and performing the task.[7] Evidence has shown that selecting strategies that incorporate an external focus of attention (EFA), or one which directs an individual's attention to the effect their movement has on the environment, versus an internal focus of attention (IFA), in which attention is drawn to the movement of the individual's body, is optimal in producing superior motor performance and best affecting the motor learning experience. Therapists in musculoskeletal rehabilitation can take advantage of such principles and their effect on the brain in order to achieve greater, more holistic and lasting recovery from movement impairments for their patients.

The purpose of this review is to summarize the basic principles of motor learning and available evidence on the influence an EFA has on motor learning and performance, including the benefits of an EFA over an IFA and how therapists may inadvertently encourage the latter. Furthermore, the benefits of possessing greater awareness of neurocognitive mechanisms are discussed to exhibit how implementing such concepts into musculoskeletal rehabilitation can maximize treatment outcomes.

## MOTOR LEARNING

Fostering proficiency of movement is an essential aspect of musculoskeletal clinical practice. While therapists routinely utilize established metrics to quantify treatment gains, measuring and defining the basis of motor learning can be somewhat more challenging. This is primarily because motor learning reflects an internal process of the central nervous system in response to practiced repetition.[8] Because this phenomena cannot be directly measured, it must be inferred by permanent changes in behavior.[8] Schmidt and Lee have defined motor learning as "a set of processes associated with practice or experience leading to relatively permanent changes in the capability of movement".[8,p.327]

One way motor learning is objectified is through the observation of improved motor behavior, or performance. Although practice alone does not always make perfect, it will generally lead to improved sequencing of segmental movement components and greater efficiency in the production of the motor task.[9] Performance at any given time, however, is highly variable and influenced by many factors. As such, performance in and of itself does not always reflect actual learning,[8] and further criteria must be demonstrated to distinguish between the two.

Several principles that reflect learning are retention and generalization. Retention represents the ability to demonstrate a skill over time, especially when the skill persists after a period without practice.[9] Generalization occurs when a learned skill in one setting can be applied to another.[8] Consider a clinical example of a patient receiving treatment after a lower extremity injury. The therapist may initially focus treatment on an isolated task, such as squatting. Sequencing criteria would be established, and the patient's performance would be observed over a set period of time. Once the patient is able to show consistent performance and independence (i.e. without the need of augmented feedback from the therapist), the skill would be considered retained. The next progression for the patient would be to take this foundational movement pattern and utilize it in a different environment than that of the controlled environment provided by the clinic. In this case, the patient could then apply this skill to sitting in a chair at home, demonstrating generalization.

A final component to consider in measuring motor learning is adaptability. Variability is a crucial component in considering dynamic and biological systems. Davids and colleagues stated that "variability in movement systems is omnipresent and unavoidable due to the distinct restraints that shape each individual's behavior". [10,p.245] Adaptability accounts for an individual's capacity to accommodate variability and different constraints, whether personal, environmental or task specific.[10] In the previous example, the patient would be demonstrating adaptability if he/she were now able to sit proficiently while riding on a moving team bus, and negotiating around team supplies and equipment laid out around them.

The ability for an individual to transfer a learned motor skill away from the instructional environment of the clinic, in order to maximize their participation in life events, should be a gold standard for the physical therapist. Permanence of skills and their adaptability exemplify true motor learning and highlight the role that cognition and motor learning play in achieving recovery from motor impairment.

## EXTERNAL FOCUS OF ATTENTION

Attentional focus is an important factor influencing motor performance and skill acquisition. It consists of an individual's ability to control the conscious appreciation of their environment and various elements to a task at hand.[11,12] It can influence the learner's ability to achieve and retain skilled movement considerably.[7] The Physical Therapist's verbal instructions to the patient, or learner, are an important element in musculoskeletal rehabilitation. They can be used to guide attention, direct the patient to visualize and recall movement, and introduce, correct and refine movement patterns. In an effort to evoke the most effective spatio-temporal components during treatment interventions, these instructions may be communicated to patients in a manner that draws their attention to specific joints, body segments, tissues, etc., producing an IFA. Durham and colleagues[13] described this concept in their study observing the feedback and instructional tendencies of therapists during treatment of individuals with hemiplegic upper extremities. Of the 247 feedback statements identified and assessed in the study, 236 had an internal focus of attention, relating to body movement rather than the effect of the patient's movement on the environment.

Although no evidence exists to explain the reason for the preponderance of IFA in practice, it has been suggested that elements of the physical therapy educational curricula, such as traditional views of muscle function and the primacy of structure over function, or the division of class offerings into independent systems of the body, foster a segmentalized view of the human movement system.[14,15] These elements may facilitate clinical practice that minimizes the role of neurological and cognitive aspects of motor control. Clinicians' efforts to further specialize in specific areas of expertise (i.e. orthopedics, or sports medicine) may further compound the problem by narrowing practice preferences.[16]

A caveat to directing a patient's attention internally is that use of an IFA has been shown to be detrimental and degrading to the motor learning process.[17] The constrained action hypothesis has been utilized to explain this occurrence.[18,19] According to this theory, individuals adopting an IFA will consciously control their movement efforts in learning a motor skill.[20] This action may *constrain* the more natural or reflexively occurring efforts utilized in the brain during this process.[20] In contrast, an EFA allows for freer, more automatic control of afferent processing, resulting in more effective performance and learning.[7,20]

Supporting evidence for the use of an EFA has mounted and contributed to the body of evidence related to strength and conditioning and sports performance. An EFA has been shown to enhance the accuracy of such sporting skills as golf shots,[21] basketball free throws,[20,22] sprint performance,[12] tennis serves[23] and soccer kicks.[23] In the latter example, Wulf and colleagues[23] had experienced soccer players perform lofted kicks at a target placed 15 meters away in a net, under two sets of instructional statements worded slightly different from one another (one internal, one external). The internal group had such statements that guided the participant to their own body movements. The external group received wording that minimized body-movement reference, and focused on the movement's effect. The small variation in word choice led to greater accuracy in hitting the target on a one-week, non-feedback retention test for those who received the externally focused instructions.[23]

In addition to this pool of literature, attentional focus research has expanded into covering scenarios and demographics commonly represented in musculoskeletal rehabilitation. Welling and colleagues[24] studied the effects of different types of instruction on landing technique and jump performance. The study aimed to highlight the potential effect of an EFA in optimizing anterior cruciate ligament injury prevention programs. Ten subjects were randomized across four groups: those receiving verbal instructions directing an EFA towards the effect of the subject's movement, those receiving verbal instructions directing an IFA towards the subject's body during the task, video instruction in which subjects would watch expert demonstration of the task, and a control group which did not receive any specific instructions. All subjects were familiarized with the task during pre-testing. Landing technique was evaluated using the Landing Error Scoring System, and jump height was taken as a performance measurement. A one week, non-instructional retention test was performed to assess true motor learning. Of the four conditions, video and EFA instructions led to superior landing technique and greater skill retention, showing to have considerable potential for the use in ACL injury prevention programs.

Many of the studies examining an EFA involve healthy and young subjects, but the positive effects shown in these studies have also been demonstrated among individuals who have suffered injury or are affected by disease process, disability or advanced age. In one study, Landers and colleagues[26] investigated the use of an EFA to see how well it lessened balance impairment in individuals with Parkinson's disease, and a history of falls. The study focused on performance effects of EFA, and not on the effect it has on learning, or retention of skill. Twenty-two participants diagnosed with idiopathic Parkinson's disease by a neurologist were chosen for the study, ten that had experienced an unexplained fall in the last year. Three conditions were chosen from the Sensory Organization Test to administer to the subjects using computerized dynamic posturography (NeuroCom Smart® Balance Master system). The subjects were familiarized with the testing equipment and the three conditions (eyes open, fixed support surface and surround; eyes closed, fixed support surface and surround; eyes open, sway-referenced support surface and fixed surround). Each subject then performed each condition under three different attentional focus instructions: EFA instructions, IFA instructions, instructions with no attentional focus implied (control). Data were gathered and analyzed for all 22 subjects collectively, then analyzed separately for the ten who had suffered a fall. When both groups were considered together, no significant performance advantage was found in utilizing EFA instructions. However, for the ten subjects with a fall history, following EFA instructions were beneficial in reducing postural sway under the sway-referenced condition as compared to IFA instructions, and instructions without attentional focus. Furthermore, when the number of falls occurring during sway-referenced task performance was analyzed in this small group, four falls were recorded under no attentional focus instructions, three falls under IFA instructions, and no falls were found while following EFA instructions.[26]

Similar results have been found in other studies. Chiviacowsky and colleagues[27] investigated the effects of inducing an EFA versus an IFA during a balance task in older adults (mean age = 69.4 years). Thirty-two participants (24 female and 8 male) were quasi-randomized (it was required that each group contain the same number of male and female participants) into two equal groups: those receiving EFA instructions during balance task, and those receiving IFA instructions. The EFA group was instructed to keep markers on a balance platform horizontal, while the IFA group was instructed to keep their feet horizontal. Participants were required to stand on the balance platform, and maintain a horizontal position as best as possible during 30-second trials. The practice phase of the study consisted of ten 30-second trials, with 90-seconds of rest between each trial. The retention phase of the study consisted of non-instructional task performance one day later, of five 30-second trials, again with 90-second intervals between trials. The results of the study demonstrated performance improvements by both groups across retention trials, but the EFA group was more effective in doing so, registering significantly greater time in balance as compared to their counterparts. Gokeler et al[28] examined the effect of attentional focus on distance of, and knee kinematics during single-leg hop jump with patient's status post anterior cruciate ligament reconstruction. Sixteen patients (seven females and nine males) were randomized into two equally sized groups of eight participants, with one group receiving EFA instructions, and the other receiving IFA instructions. Jump distance, knee valgus angle at initial contact, peak knee flexion angle, total range of motion and time to peak angles for the injured and non-injured side were assessed. The EFA group jumped 6-11 cm further than the IFA group, however after statistical analysis, this was deemed to be an insignificant finding. Participants who received the externally directed instructions demonstrated important changes in knee kinematic markers, recording larger peak knee flexion angles at initial contact for the involved side, and greater peak knee flexion angles for both legs. This indicated that participants in the IFA group displayed stiffer landing strategies in the sagittal plane, which studies have associated with greater strain to the anterior cruciate ligament.[29]

Researchers and clinicians have begun to study the efficacy of gait retraining as an intervention strategy to address some of the common injuries experienced by runners. Crowell and Davis[30] studied the efficacy of a gait retraining program designed to reduce lower extremity loading during running. Ten healthy runners (six female, four males) participated in the study. With use of an accelerometer and force plate, tibial acceleration and ground reaction forces were collected pre-training, post-training and at one month follow up. Loading variables of interest were peak positive tibial acceleration, vertical instantaneous loading rate, vertical average loading rate and vertical impact peak. Participants selected for the study had registered tibial acceleration measurements of over 8g during screening. Gait re-training consisted of eight sessions of treadmill running over a course of two weeks. During each session, tibial acceleration was displayed on a monitor in front of the participant to provide real-time video feedback. The subjects were instructed to "run softer", make their footfalls quieter and keep the acceleration peak below a set threshold line on the monitor. Running time over the eight sessions increased from 15-30 minutes, while feedback was lessened over the last four sessions. The authors chose this feedback schedule because reduced external feedback requires greater reliance on the processing of inherent information related to the performed task, leading to greater retention of a motor skill and motor learning.[31,32] The program resulted in a decrease of all interested loading variables and supports an alternative and potentially promising approach to addressing run-related injury. Although there was no explicit focus on the use of an EFA in this study, subjects were instructed to "run softer" and to make their footfalls quieter. These instructions and wording constitute an EFA, as the learner is instructed to modify the effect of their movement on the environment, rather than the components of the movement itself.

In the early (cognitive) phase of learning, individuals are susceptible to various forms of interference as they begin to process and identify what the specific task is being presented. The conditions of Crowell and Davis's experiment draw some parallels to that of Welling and colleagues' previously described in this article, as they both expose participants to some type of visual media and verbal instructions with an EFA. In these cases, positive effects on performance and motor learning were observed. This example highlights the importance of further study of the utilization of an EFA in various treatment scenarios encountered during musculoskeletal rehabilitation.

## DISCUSSION

The ultimate goal of musculoskeletal rehabilitation is to address the injury, ameliorate movement impairment, and promote lasting functional movement behaviors that allow patients to fully partici-

**Table 1.** *Comparison of external focus of attention (EFA) instructions, ones which direct an individual's attention to the effect their movement has on the environment, vs. internal focus of attention (IFA) instructions, which draw attention to the movement of the individual's body, during experimental procedures.*

| Study | Experimental task | EFA Instructions | IFA Instructions |
|---|---|---|---|
| Chiviacowsky and colleagues[27] | Horizontal stabilization of a balance platform (stabilometer) | "Look straight ahead. Try to keep the *markers* in front of your feet horizontal." | "Look straight ahead. Focus your attention on keeping your *feet* horizontal." |
| Gokeler et al[28] | Single leg hop jump for distance | "Jump as far as you can. While you are jumping, I want you to think about pushing yourself off as hard as possible from the *floor*." | "Jump as far as you can. While you are jumping, I want you to think about extending your *knees* as rapidly as possible." |
| Landers and colleagues[26] | Balance performance on a computerized dynamic posturography * | "Stand quietly with your eyes open and concentrate on putting an equal amount of pressure on the *rectangles*." | "Stand quietly with your eyes open and concentrate on putting an equal amount of force on your *feet*." |
| Welling and colleagues[24] | Drop vertical jump, followed by maximal vertical jump on landing | "Push yourself as hard as possible off the *ground* after landing on the force plate." | "Extend your *knees* as rapidly as possible after landing on the force plate." |
| Wulf and colleagues[23] | Lofted soccer kick at a target | "Strike the *ball* below its midline to lift it; that is, kick underneath it." | "Position your *foot* below the ball's midline to lift the ball." |

* Balance Master - Condition A: eyes open, fixed support surface and surround

pate in life experiences. Traditional approaches taken to accomplish this may lack consideration of neurocognitive contributions to the motor learning process[6] and may potentially impair them by drawing the attentional focus of the patient internally, to their own body movements, rather than externally, to the effect their movement has on the environment.[17,19] The results in this review suggest that subtle changes to the wording clinicians utilize during verbal instructions (as seen in Table 1) can have a powerful impact on motor performance and motor learning by directing a learner's focus externally rather than internally. Such results would be advantageous to efforts in achieving superior functional outcomes for our patients and maximizing the overall success of the rehabilitation process.

It is the opinion of the authors that therapists could benefit from incorporating these principles into daily clinical practice, however, there does seem to be a need for expansion of this research to better guide the integration and practice habits that would most successfully affect movement system changes. This could include expansion of research on the effectiveness of an EFA on motor learning across the lifespan, during different phases of the learning process, with different task complexity levels and between learners of different experience (i.e. novice or expert).

## CONCLUSIONS

With physical therapy's nature as an applied science, and the role of physical therapists as the practioners of choice in the treatment of the human movement system, there is a particular opportunity to use and expand upon this existing body of literature and integrate neuroscientific principles into daily practice. Physical therapists involved in the treatment of the movement system can greatly benefit from promoting an EFA through verbal instructions in order to achieve the most successful and effective movement outcomes for their patients.

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