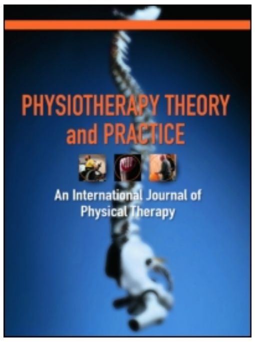

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REPORT

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Implementation of motor learning principles in physical therapy practice: Survey of physical therapists' perceptions and reported implementation

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ABSTRACT

Introduction: The field of motor learning (ML) plays a pivotal role in physical therapy (PT), and its implementation has been shown to improve intervention outcomes. The objective of this study was to assess physical therapists' ML-related self-efficacy, self-reported implementation, and environmental workplace factors. An additional aim was to report the psychometric properties of a questionnaire that was developed to assess the above-mentioned constructs. Methods: An observational, cross-sectional survey was completed by 289 physical therapists (average age: 38.7 (9.7), with 11.3 (9.7) years of experience and 74% female). Construct validity, internal consistency, and test–retest reliability were tested. The main outcome measures were the scores of the three scales of the questionnaire, referring to self-efficacy in ML, implementation of ML principles, and workplace environment features. Results: The questionnaire had sound psychometric qualities. Respondents perceived ML as an integral part of PT. ML-related self-efficacy and implementation of ML principles were moderate (2.95/5 (0.7) and 3.04/5 (0.8), respectively). PT practice had a significant effect on ML-related self-efficacy (p = 0.035) and implementation (p = 0.0031). Respondents who had undergone ML training in their graduate program reported higher ML-related self-efficacy (p = 0.007). Respondents who had postgraduate training in ML reported significantly more extensive implementation (p = 0.024). Lack of knowledge and lack of time were perceived as the major barriers to implementation. Conclusions: Level of self-efficacy might be insufficient to support the systematic implementation of ML principles in practice. Addressing impeding individual- and organizational-level factors might facilitate ML self-efficacy and implementation. Postgraduate education facilitates ML implementation.

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Evidence-Based Medicine; Motor Learning; Physical Therapy; Self-efficacy; Survey

Introduction

Motor learning (ML) principles and concepts constitute an important conceptual framework for clinical practice in physical therapy (PT) (Shumway-Cook and Woollacott, 2012) and a foundation for effective rehabilitation strategies (Kleim and Jones, 2008; Winstein et al., 2014). Thus, solid knowledge of ML is expected to inform physical therapists' (PTs) clinical reasoning and practice (Godin, Belanger-Gravel, Eccles, and Grimshaw, 2008; Jette et al., 2003). Recent developments in the study of cognitive-motivational factors in PT practice suggest that ML implementation could be enhanced through specific attitudes and beliefs, such as positive attitude and high self-efficacy (Jette et al., 2003; Salbach, Guilcher, Jaglal, and Davis, 2009; Salbach et al., 2007). Of these, self-efficacy is especially important, because it reflects one's beliefs about his/her capabilities to successfully perform a particular behavior or task. High self-efficacy increases the likelihood of successful task completion (Bandura, 1986; Bandura, 2006). Specific to the clinical context, clinical behaviors such as adherence to guidelines were associated with "beliefs about capabilities" (Godin, Belanger-Gravel, Eccles, and Grimshaw, 2008) and various barriers, including low self-efficacy, were shown to impede translation of positive attitudes into everyday clinical behaviors (Salbach et al., 2007; Scurlock-Evans, Upton, and Upton, 2014).

Although proven to be important in PT (Cramer et al., 2011; Dobkin, 2003; Kleim and Jones, 2008; Krakauer, 2006; Larin, 1998; Magill, 2011; Muratori, Lamberg, Quinn, and Duff, 2013; Sawers et al., 2012; Schmidt and Lee, 2011; Shumway-Cook and Woollacott, 2012; Snodgrass et al., 2014; Winstein et al., 2014; Wulf, Chiviacowsky, Schiller, and Avila, 2010; Wulf, Shea, and Lewthwaite, 2010; Zwicker and Harris, 2009), no systematic study or survey instrument has focused on clinical behaviors related to the implementation of ML principles. Observational studies that capture the use of ML reported incomplete implementation (Johnson, Burridge, and Demain, 2013). The current study focused on PTs' perceptions with respect to ML. A questionnaire was developed to

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gain a better understanding of factors that affect the implementation of ML principles.

Methods

The aims of this study were: 1) to report the development and testing of the Physical Therapists' Perceptions of Motor Learning (PTP-ML) questionnaire; and 2) to assess PTs' self-efficacy in the field of ML, self-reported implementation, and environmental workplace factors that affect ML implementation. The study used a cross-sectional survey design. It was approved by the local Institutional Ethics Committee, and all participants provided written informed consent.

Participants

Respondents were 289 Israeli PTs, recruited through notices posted in workplaces and professional meetings, and distributed via email or direct mailing. A subset of 28 PTs completed a test–retest procedure. Sample size calculation indicated that a sample of 254 PTs is required for surveying a population of 4,500 PTs (the estimated number of practicing PTs in Israel) at a confidence level of 90% and margin of error of 5%.

Development of the PTP-ML questionnaire

The PTP-ML is a self-report questionnaire (Supplementary 1) developed and administered in Hebrew. Its development was driven by the ML theoretical framework (Dobkin, 2003; Krakauer, 2006) and by Bandura's theory of self-efficacy (Bandura, 1986; Bandura, 2006). Review of the basic literature (Magill, 2011; Schmidt and Lee, 2011; Shumway-Cook and Woollacott, 2012) and applicable papers (Kleim and Jones, 2008; Krakauer, 2006; Larin, 1998; Levac, Wishart, Missiuna, and Wright, 2009; Muratori, Lamberg, Quinn, and Duff, 2013; Snodgrass et al., 2014; Winstein et al., 2014) was used to identify the main ML principles (e.g. dose and feedback type) and to formulate the questionnaire items.

The questionnaire encompassed three conceptual themes: 1) ML self-efficacy, which covers respondents' self-assessed knowledge and ability to explain ML principles or terms (ML self-efficacy scale); 2) respondents' self-reported implementation of ML principles (implementation scale); and 3) workplace environment factors (general scale). Items in the ML self-efficacy scale (N = 12) were rated on a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Items in the implementation scale (N = 12) were rated on a scale from 1 (very little) to 5 (very much), or alternatively, respondents noted that they were "unaware of this ML principle." Higher scores indicate higher ML self-efficacy and implementation and more enablers in the workplace for ML implementation. Two open-ended questions addressed respondents' knowledge of ML-based treatment methods and factors they believe impede implementation in practice. One item related to the relevance of ML to PTs' clinical practice was added as a screening item.

Psychometric evaluation of the questionnaire

Face validity

The questionnaire was sent to a panel of eight PTs with at least 10 years of experience in clinical work and PT education. All experts identified the constructs measured and found the selection of items to be sufficiently comprehensive.

Construct validity and internal consistency

Exploratory factor analysis was performed using a Varimax rotation method to test the factor structure in comparison with the conceptual categories (ML self-efficacy, implementation, and general scales). Scales were analyzed to test internal reliability using Cronbach's alpha (values between 0.70 and 0.90 were considered adequate). Inter-correlations between scales were tested using Pearson correlations.

Test–retest reliability

To explore test–retest reliability, 28 respondents completed the questionnaire twice within a period of 14 days. Reliability was determined by intraclass correlation (ICC) coefficient (two-way random effects, absolute agreement) and confidence intervals (CI). For single items, an ICC > 0.5 was accepted, whereas for scales and total score, an ICC coefficient > 0.7 was accepted.

Analysis of the PTP-ML questionnaire scores

The score of each scale was the average of all items within that scale. The total questionnaire score was the mean of all items within the questionnaire. Inter-correlations between scales as well as associations between scores and background variables were calculated. Experience was divided into three categories, and their correlation with ML training was tested using the Chi-squared test. Differences in scale scores by field of practice and work setting were tested using one-way analysis of variance (ANOVA). SAS software was used, and p-values equal to or less than 0.05 were considered significant.

Results

Participants

Respondents' demographics and professional background are presented in Table 1. Six respondents were excluded from the analysis: two reported that ML is irrelevant to their practice and four answered less than half of the items.

Psychometric evaluation of the questionnaire

The distribution of scores was normal. There were 48 missing values spread across 20 items.

Factor analysis and internal consistency

The model showed a three-factor structure explaining 52% of the variance. Item loading was found to be sufficient (Table 2). The resulting structure included three scales (ML self-efficacy, implementation, and general scales) fitting with the conceptual structure, except for two items that had been placed in a factor that they conceptually fit, yet loaded more strongly on a different factor. However, factor loading on the new factor was still satisfactory (above 0.31).

Table 1. Demographic and professional background of the respondents (N = 283).

Characteristic variables	Mean (SD), range
Age (years)	38.7 (9.7), 22–66
Years of experience:	11.3 (9.7), 1–42
	Frequency in % (number of participants)
≤ 5 years	36% (102)
6–20 years	45% (127)
> 20 years	19% (54)
Highest degree: Bachelor's, Master's, PhD	76% (215), 22% (62), 2% (6)
Gender	Female 74% (209)
Employment:	
Full time or more	28.3% (78)
Full time - half time	63.3% (179)
Half time	5.1% (14)
Less than half time	1.8% (5)
Main field of practice:	
Neurology and orthopedic	27.2% (76)
Orthopedic	27.6% (77)
Neurology	19.7% (55)
Geriatrics*	6.5% (18)
Pediatrics	6.5% (18)
Respiratory	2.2% (6)
Mixed**	10.4% (29)
Work setting:	
Orthopedic outpatients	34% (95)
Rehabilitation center	35% (97)
General hospital	10.7% (30)
Geriatric center	6% (17)
Home care	1.4% (4)
Pediatric settings	5% (14)
Other	(8%)

*Does not include geriatric rehabilitation.
**Respondents who marked more than two main PT domains.
SD: standard deviation; PT: physical therapy.

Table 2. Scores, internal consistency, and test–retest reliability of the different scales of the questionnaire (N = 283).

	Scales' scores	Internal consistency	Item loadings	Test–retest reliability	
Scale	Mean (SD)	Cronbach's α	Range	ICC	90% CI
ML self-efficacy	2.95 (0.7)	0.89	0.36–0.76	0.65	0.25–0.84
Implementation	3.04 (0.8)	0.82	0.31–0.83	0.88	0.73–0.95
General	2.65 (0.9)	0.72	0.51–0.8	0.81	0.58–0.91
Total	2.88 (0.7)	0.92		0.84	0.65–0.92

ML: motor learning; SD: standard deviation; ICC: intraclass correlation coefficient; CI: confidence interval.

Cronbach's alpha values of all scales, and total questionnaire score (Table 2), were greater than 0.70, indicating good internal reliability (DeVellis, 2012). Intercorrelations between scales suggest that the scales are related, yet represent distinct constructs (ML self-efficacy and implementation: r = 0.62, $p > 0.0001$; ML self-efficacy and the general scales: r = 0.41, $p > 0.0001$; and implementation and the general scales: r = 0.47, $p > 0.0001$).

Test–retest reliability

ICC and 90% CI are reported in Table 2. Most items showed good reliability. The ML self-efficacy scale showed somewhat low, albeit acceptable, reliability (r = 0.65).

PTP-ML questionnaire findings

The mean score (standard deviation) of the screening item was 4.74 (0.57), with 96% of the respondents strongly agreeing that ML is relevant to their clinical practice. The mean total score was 2.88 (0.7). Tables 2 and 3 present scale and item scores.

ML self-efficacy scale

The mean total score of this scale was 2.95 (0.7). The item variability of practice received the highest score (3.53 (1.04)). The lowest was related to perceived ability to teach ML to PT students (2.26 (0.99)). Regarding specific ML principles, 33% of the respondents had limited confidence in their ability to explain the effect of repetitions on ML and 40% did not feel confident about explaining the differences between the two types of feedback. Respondents had the least confidence in their ability to explain positive reinforcement. Only 36% of the respondents were confident about their theoretical understanding of ML, whereas 18% felt very insecure. Furthermore, whereas 24% felt confident in their ability to provide treatment based on ML, 29% felt unable to do so.

Table 3. Mean score and distribution of items' score.

Relevance of motor learning in physical therapy practice	Mean (SD)		Strongly disagree/ Disagree (frequency)	Neutral (frequency)	Agree/Strongly agree (frequency)
*1. "I feel that motor learning principles are relevant to my field of practice (e.g. neurology, orthopedic)."	4.74 (0.57)		1.1%	3.2%	95.8%
Part A: Motor learning self-efficacy item.	Mean (SD)		Strongly disagree/ Disagree (Frequency)	Neutral (Frequency)	Agree/Strongly agree (Frequency)
2. "I feel that I understand motor learning principles on a theoretical level."	3.27 (0.92)		17.7%	45.9%	36.4%
3. "I feel confident that I can provide treatment based on the principles of motor learning."	2.98 (0.89)		29.3%	46.3%	24.4%
4. "I feel that I need a lot of training in motor learning in order to be able to use this approach in my practice."	2.95 (1)		31.8%	38.2%	30.0%
5. "I feel that I can explain to someone else the difference between giving instructions using "external focus of attention" compared to "internal focus of attention."	2.89 (1.14)		39.7%	29.8%	30.5%
6. "I feel confident in my ability to explain to someone else the concept of variability of practice."	3.53 (1.04)		16.0%	29.4%	54.6%
7. "I feel confident in my ability to explain to someone else the concept of random order of practice versus blocked or serial order of practice."	3 (1.13)		35.5%	29.4%	35.1%
8. "I feel confident in my ability to explain to someone else the two types of feedback: "knowledge of results" and "knowledge of performance."	2.69 (1.23)		47.3%	26.9%	25.8%
9. "I feel confident in my ability to explain to someone else the relationship between the extent of repetitions within practice and motor learning."	3.04 (1.03)		32.9%	36.1%	31.1%
10. "I feel confident in my ability to explain to someone else the practical meaning of positive reinforcement (reward) in the context of motor learning."	2.45 (1.05)		60.2%	22.9%	16.8%
11. "I feel confident in my ability to explain to someone else the components that make practice specific."	2.93 (1.05)		36.4%	32.9%	30.7%
12. "I have no difficulty implementing the principles of motor learning in physical therapy treatments."	3.4 (0.97)		17.1%	32.1%	50.7%
13. "I feel confident in my ability to teach physical therapy students how to use motor learning principles in their treatment."	2.26 (0.99)		62.9%	25.2%	11.9%
Part B: Self-reported implementation of motor learning principles item.	Mean (SD)	Unaware	Very small/Small degree (frequency)	Moderate degree (frequency)	Large/Very large degree (frequency)
1. "To what extent does your practice involve motor learning"?	3.9 (1.02)	1.1%	6.4%	25.4%	67.1%
2. "To what degree do you implement the principles of motor learning in your practice"?	3.22 (0.97)	1.8%	14.7%	45.9%	37.6%
3. "To what degree do you plan whether to give instructions using "external focus of attention" or "internal focus of attention"?	2.30 (1.48)	20.6%	26.6%	31.2%	21.6%
4. "To what degree do you use variability of practice"?	3.43 (1.31)	7.5%	8.5%	27.8%	56.2%
5. "To what degree do you modulate environmental factors and motor demands to generate challenge during practice"?	4.01 (1.27)	6.4%	1.8%	10.2%	81.6%
6. "To what extent do you plan whether the feedback you give will be based on "knowledge of results" or "knowledge of performance"?	2.1(1.49)	23.0%	37.5%	19.1%	20.5%
7. "To what extent do you plan the timing and frequency of the feedback you give"?	2.39 (1.36)	13.5%	36.5%	27.0%	23.0%
8. "To what extent do you attribute importance to the extent of practice (i.e., repetitions)"?	3.44 (1.26)	6.4%	10.3%	25.9%	57.4%
9. "To what extent do you structure the number of repetitions within a practice"?	2.92 (1.2)	7.1%	21.6%	37.8%	33.6%
10. "To what extent do you include positive reinforcement (reward) in the learning process"?	2.06 (1.35)	20.0%	39.3%	26.8%	13.9%
11. "To what extent do you use outcome measures to monitor the learning process"?	3.13 (1.15)	2.8%	21.7%	35.6%	39.9%
12. "To what extent do you structure your practice to be specific"?	3.6 (0.84)	1.1%	6.0%	32.6%	60.3%
Part C: General attitudes and perceptions about the workplace environment item.	Mean (SD)	Not relevant	Very small/Small degree (frequency)	Moderate degree (frequency)	Large/Very large degree (frequency)
1. "To what extent do you devote time to plan practice variables (e.g. order of practice, frequency of feedback)"?	2.72 (0.91)	1.8%	35.7%	45.6%	17.0%
2. "At your workplace, to what extent you are given enough time to treat patients according to the principles of motor learning"?	2.65 (1.4)	10.7%	31.8%	28.2%	29.3%
3. "I can consult with my peers at my workplace about giving motor-learning based treatment."	2.58 (1.38)	8.5%	37.8%	25.1%	28.6%
4. "To what extent do physical therapists in your field employ the principles of motor learning"?	2.64 (0.98)	3.9%	34.9%	46.3%	14.9%

*Informative and screening item, not included in the domains' score calculation.
SD: Standard deviation

Implementation scale

The mean total score of this scale was 3.04 (0.8). Overall, 61% of the respondents reported that they implement ML to a moderate, small, or very small degree. High or very high levels of implementation were reported for specific elements: grading the difficulty levels within practice, practice of specific tasks, and variability of practice (82%, 60%, and 56%, respectively). The scoring scheme used in this scale allowed rating items as "unaware" of. High "unaware" ratings were reported for type of feedback (23%), instructions focus of attention (20.6%), positive reinforcement (20%), and timing of feedback (13.5%).

General scale

Scores ranged from 2.58 to 2.72. Two items were related to the workplace environment: opportunities for consultation on ML with peers and time resources. Very low, low, and moderate opportunities for consultation with peers were reported by 63% of the respondents; very limited, limited, and moderate time resources were reported by 60% of the respondents. In addition, only 17% of the respondents indicated that ML implementation in their field of practice is extensive or very extensive, and 35% reported limited or very limited implementation. Only 17% of the respondents reported that they plan practice variables (e.g. dose and feedback type) to a large or very large degree, whereas 36% reported limited or very limited planning of their interventions.

Associations between variables

There were no significant correlations between age or experience and the scales' scores or the total questionnaire score. After dividing respondents into three subgroups by years of experience, a significant moderate-to-strong association (Cramer's V = 0.42) emerged between experience and graduate-level ML training ($\chi 2 = 71.7$, $p < 0.001$).

Field of practice had a significant effect on ML self-efficacy ($F(4, 250) = 2.63$, $p = 0.035$), implementation ($F(4, 250) = 4.1$, $p = 0.0031$), and total scores ($F(4, 250) = 3.81$, $p = 0.0051$) (Figure 1). Post hoc analysis showed that respondents who worked in pediatrics had significantly higher scores on ML self-efficacy ($p = 0.03$) and implementation ($p = 0.05$) and a higher total score ($p = 0.03$) than did respondents involved in multiple PT fields of practice. The work setting effect on the general scale showed a statistical trend ($F (4, 245) = 2.3$, $p = 0.06$).

Respondents who received some graduate-level ML training (n = 152) had significantly higher scores on ML self-efficacy ($t(244) = 2.74$, $p = 0.007$, 95% CI = 0.02–0.37) and higher total scores ($t(244) = 2.28$, $p = 0.024$, 95% CI = 0.03–0.37) than others (n = 94), whereas the implementation and total scores of these groups did not significantly differ. In addition, participants who reported ML postgraduate training (n = 75) scored significantly higher on the implementation scale ($t(263) = 2.28$, $p = 0.024$, 95% CI = 0.35–0.48) and on the total questionnaire score ($t(263) = 2.28$, $p = 0.022$, 95% CI = 0.03–0.38) than did the others (n = 190).

Barriers to ML implementation

The reported barriers to implementation are listed in Table 4. The most frequently mentioned barrier was insufficient knowledge, followed by lack of time. Insufficient knowledge was described using phrases such as "overload of terms," "lack of solid understanding of the principles," "it is simply unclear," and "This topic is not yet disseminated."

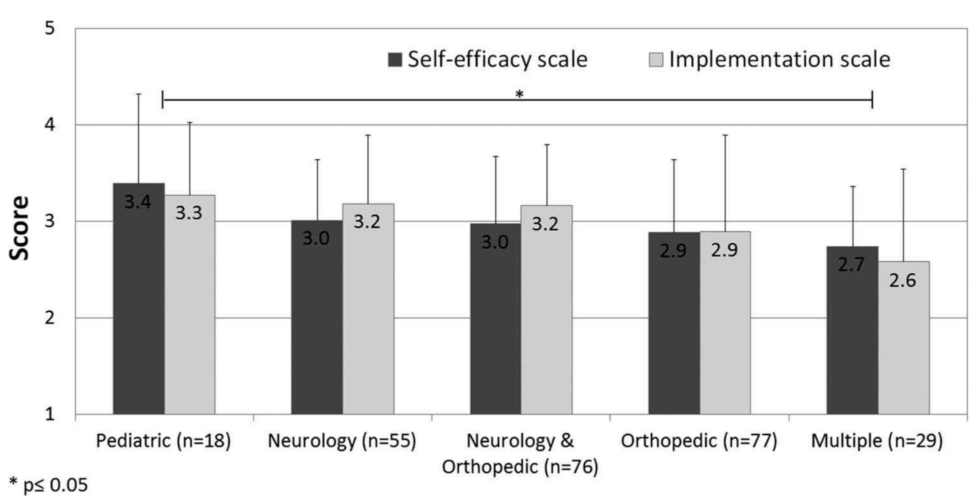

Figure 1. Scores of self-efficacy and implementation scales divided by field of practice in physical therapy.

Table 4. Reported barriers to implementation of motor learning principles in physical therapy interventions. Data reported as frequency and number of respondents.

Barriers related to clinician's resources	
Lack of knowledge	38.2% (108)
Working habits	15.3% (15)
Barriers related to work environment features	
Lack of time	32.2% (91)
Overload at work	8.8% (25)
Environmental factors, including limited space, crowded and noisy treatment environment, lack of equipment, treatment environment does not simulate a real-world environment	7.4% (21)
Healthcare system-related barriers, including the need to treat patients with very diverse diagnoses, limited number of sessions, safety demands, supervisor does not believe in the relevance of motor learning principles to PT practice	2.5% (7)
Barriers related to features of motor learning	
The characteristics of patients (such as lack of motivation, very severe functional limitations, age)	9.2% (26)
Complexity of motor learning-based intervention, e.g. multiple elements to implement, many repetitions, specific training	7.1% (20)
Institutional focus on quantitative changes and not qualitative	1.4% (4)
Boring because of many repetitions	1.1% (3)
Multiple treatment goals	0.4% (1)

Table 5. Summary of report about specific motor learning-based treatment methods.

Specific treatment method	Number of respondents
Neurodevelopmental Treatment	20
Specific motor learning principles (repetitions, variability of practice, specificity, etc.)	10
Neuro-Ifrah	8
Constraint-induced movement therapy	8
Gym workout	4
Task-specific training	4
Pilates	4
Proprioceptive Neuromuscular Facilitation (PNF)	4
Gym workout	4
Rehabilitation after sports injury	3
Biofeedback	2
Mirror therapy	2
McKenzie method	2
Virtual reality	2
AposTherapyTM	2
Feldenkrais practice	2
Re-StepTM practice	1
Mulligen concept	1
Vojta method	1
Vestibular intervention	1
Hold/relax technique	1
Dual task training	1
Muscle strengthening	1
External cues for Parkinson's disease	1
Medek method	1
General (e.g. "intervention in neurological conditions")	3

Knowledge of MLl-based treatment methods. Sixty-seven respondents reported that they are familiar with intervention approaches based on ML, 160 reported they are not, and 56 did not answer this question. As illustrated in Table 5, respondents listed a variety of treatment methods based on ML.

Discussion

This study was motivated by the fundamental role of ML in PT practice, and the potential influence of self-efficacy and environmental factors on the actual implementation of ML principles. This line of inquiry joins a body of literature that emerges around models of practice in PT (Nicholls and Gibson, 2010) and knowledge translation (Jones et al., 2015). While confirming that PTs subscribe to the prevailing notions of the key role of ML in PT practice (Larin, 1998; Levac, Wishart, Missiuna, and Wright, 2009; Snodgrass et al., 2014; Winstein et al., 2014; Zwicker and Harris, 2009), the findings of this study underscore gaps between this appreciation and the actual implementation of ML principles in practice.

ML self-efficacy scale

Respondents reported only moderate confidence in their knowledge and in their ability to explain concepts related to ML. Lack of knowledge was also the most frequently reported barrier to ML implementation. Most respondents also expressed limited confidence in their ability to teach students how to use ML principles, which is not surprising, as teaching demands in-depth comprehension and use of higher-level thinking processes in order to frame and articulate the knowledge (Laitinen-Vaananen, Talvitie, and Luukka, 2007). Such limited confidence may affect professional development in the field (Laitinen-Vaananen, Talvitie, and Luukka, 2007).

Despite the importance given to repetitions as a critical variable in the learning process, a high percentage of participants reported limited confidence in their ability to explain the effect of repetitions (Krakauer, 2006; Winstein and Campbell Stewart, 2006). Another concept that has attracted attention in the literature, yet on which respondents reported low self-efficacy, was types of feedback (Magill, 2011; Schmidt and Lee, 2011; Van Vliet and Wulf, 2006; Wulf, Chiviacowsky, Schiller, and Avila, 2010). Respondents' reported low self-efficacy in positive reinforcement might have been affected by the wording of this item, which focused on the difference between feedback and positive reinforcement, which is ambiguous. Therefore, to avoid confusion, this item was changed to focus on positive reinforcement. The revised item is presented in the current version of the questionnaire (Supplementary 1).

Characteristics of the ML literature might impede its application in practice and partly explain the moderate levels of self-efficacy found in the current study. Zwicker and Harris (2009) indicated that ML theories are characterized by complexity, lack of clarity, and low accessibility for clinicians, and specifically lack of uniformity of terms, insufficient definition of core elements, and lack of an integrated perspective (Kleynen et al., 2014; Wulf, Shea, and Lewthwaite, 2010). The limited number of ML-based treatment methods listed by respondents further emphasizes the lack of adequate knowledge of ML, and specifically its clinical applications. Even interventions that are directly drawn from the ML literature, such as task-specific training or "constraint-induced movement therapy" (Carr and Shepherd, 2010; Dobkin, 2003; French et al., 2010; Winstein and Campbell Stewart, 2006), were mentioned by only a few respondents. Some respondents mentioned PT methods that either adopted ML over time (e.g. neurodevelopmental treatment) (Lennon and Ashburn, 2000) or were retrospectively analyzed for their ML components (e.g. Feldenkrize) (Connors, Galea, Said, and Remedios, 2010). In addition, some responses (e.g. "McKenzie" or "hold-relax") demonstrate that ML-based interventions are viewed by some respondents as a catch-all term. These findings suggest that PTs' knowledge of ML warrants reinforcement if it is to support the effective delivery of structured, ML-oriented interventions.

Implementation scale

The moderate degree of self-reported implementation further supports the notion that it is not a straightforward process and might require active facilitation. Findings reveal variability in implementation of the various ML principles. It seems that respondents are familiar with and implement the principles of grading practice difficulty, practice of specific tasks, and variability of practice. Indeed, the concepts of variable, challenging, and task-specific practice are well-established premises in the ML and PT literature (Kleim and Jones, 2008; Magill, 2011), and might be relatively clear and easy to implement among most patient populations. Although the number of repetitions is a core principle of ML (Kleim and Jones, 2008; Krakauer, 2006; Larin, 1998; Levac, Wishart, Missiuna, and Wright, 2009; Muratori, Lamberg, Quinn, and Duff, 2013; Sawers et al., 2012; Winstein et al., 2014), only 57% of the respondents attributed high or very high importance to this concept. Moreover, the substantial number of concepts marked "unaware," such as type of feedback, focus of attention, and positive reinforcement, could be associated with the challenges these concepts pose for implementation or with respondents' lack of familiarity with current research. For clinical purposes, it will be valuable to identify the applicability of each concept within the clinical context. However, this is beyond the scope of this study.

General scale

Findings indicate that ML implementation might also be undermined by limited professional support and time resources in the work environments. This, together with respondents' low-to-moderate estimations of ML implementation by other PTs in their field of practice, suggests that the workplace environment might not promote professional development in the field of ML sufficiently. These findings are consistent with previous reports on organizational-level barriers, and specifically lack of time, which is one of the barriers to adopting evidence-based practice (EBP) most frequently reported by healthcare professionals (Griffiths et al., 2001; Heiwe et al., 2011), including PTs (Jette et al., 2003; Salbach et al., 2007). Interestingly, when referring to EBP in nursing, it has been suggested that lack of time may be a socially acceptable justification for low interest, knowledge, and/or motivation (Glacken and Chaney, 2004). It is therefore important to discover how time functions as a barrier to ML implementation and whether it is a proxy for other more complex barriers.

Reported lack of planning PT sessions potentially undermines effective implementation, especially in ML-based practices that require the specification of multiple elements (e.g. type and frequency of feedback and dose). Interestingly, some respondents viewed the need for planning as a barrier to implementation.

Associations between variables

Respondents with high self-efficacy were most likely to have higher implementation scores, reflecting an association between self-efficacy and reported implementation. However, it should be noted that EBP studies in PT note the disparity among research awareness, critical appraisal skills, and practice, and suggest that high self-ratings of EBP skills do not necessarily translate into more frequent or more accurate implementation (Iles and Davidson, 2006; Salbach, Guilcher, Jaglal, and Davis, 2010; Scurlock-Evans, Upton, and Upton, 2014).

Mean scale scores did not differ by experience, suggesting that the findings are relevant to PTs in general. The highest scores were found for PTs working in pediatrics, which might reflect the unique emphasis on motor skills acquisition in this field (Larin, 1998; Levac, Wishart, Missiuna, and Wright, 2009). This emphasis might be linked to the natural context of ML in child development compared with adults, in which the emphasis is on regaining specific skills (Gordon and Magill, 2012). Following this line of thought, in pediatric and neurologic rehabilitation, there is an inherent emphasis on ML due to the salience of skills acquisition, whereas ML may receive less attention in other areas of practice in PT. Interestingly, recent publications indicate the need to increase integration of ML principles into musculoskeletal PT (Snodgrass et al., 2014) and amputation rehabilitation (Sawers et al., 2012) and offer frameworks for knowledge translation in these clinical settings.

Novice PTs reported a higher rate of ML training in their undergraduate studies, which may reflect the growing professional awareness of ML. Interestingly, those who participated in postgraduate training had significantly higher implementation scores and total scores, suggesting that postgraduate training might be an effective tool for facilitating ML implementation.

Several limitations of this study should be considered. This study surveyed PTs in Israel; hence, generalizability to other countries should consider professional differences. Furthermore, findings are based only on PTs' self-reports, which are a proxy measure of actual clinical behavior.

Conclusions

The study sheds light on the current state of ML self-efficacy among PTs, self-reported implementation, and possible barriers for implementation of ML principles. PTs confirmed that ML is an important part of physiotherapy practice; however, there are gaps between the extent of theoretical knowledge of ML principles in the literature and their implementation in clinical practice. PTs have moderate self-efficacy in the field of ML, which may be insufficient to support a high standard of implementation. The findings distinguished between ML concepts that may be easier to understand and implement and concepts that are more challenging to master. The findings confirm the contribution of postgraduate education in facilitating ML implementation.

Declaration of interest

The authors declare that they have no competing interests.

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Date: ______________

Appendix 1: Physical Therapists' Perceptions of Motor Learning (PTP-ML)

This questionnaire is about your thoughts on motor learning. It will take you about 20 minutes to complete the questionnaire. Please answer all of the following questions.

= =

Demographic and professional information

Demographics:

Age: __________ Country of birth: ____________

Gender: ☐M ☐F

Personal status: ☐ Single ☐ Married ☐ Other, please specify: ________

Place of residence: ☐ City ☐ Other, please specify: ____________

Education and Professional Experience:

Occupation: ☐ Physical Therapist ☐ Other, please specify: ____________

What is your main field of practice in physical therapy: ☐ Neurology ☐ Orthopedic ☐ Pediatrics ☐ Geriatrics ☐ Other, please specify: ___________
What is your main work setting ☐ Orthopedic outpatient clinic ☐ Rehabilitation hospital ☐ General hospital ☐ Nursing home/Geriatric day center ☐ Home visits ☐ Child development clinic ☐ Educational system ☐ Other, please specify: ______________
What is your secondary field of physical therapy practice (you may check more than one field): ☐ Neurology ☐ Orthopedic ☐ Pediatrics ☐ Geriatrics ☐ Other, please specify: ___________
What is the secondary work setting in which you work (you may check more than one): ☐ Orthopedic outpatient clinic ☐ Rehabilitation hospital ☐ General hospital ☐ Nursing home/Geriatric day center ☐ Home visits ☐ Child development clinic ☐ Educational system ☐ Other, please elaborate: ______________

Number of hours of work per week ___;

Highest academic degree: ☐ BA ☐ MA ☐ PhD; Year received your BA ______ Year received the highest degree ___________

Number of years of experience in the profession: ___________

Training in Motor Learning:

Did your undergraduate physical therapy curriculum include a course that focused exclusively on motor learning? Yes/No. If yes, please describe: ___________________________

Did any courses in your undergraduate studies include lectures about motor learning? Yes/No. If yes, please describe: ___________________________

Did you participate in post-graduate courses that focused specifically on motor learning?

Yes/No. If yes, please describe (name of the course and scope): ___________________________

= =

Relevance of motor learning in physical therapy practice.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel that motor learning principles are relevant to my field of practice (e.g. neurology, orthopedic).	1	2	3	4	5

Part A: Motor learning self-efficacy

Please mark the most appropriate response to each statement based on your personal opinion.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel that I understand motor learning principles on a theoretical level.	1	2	3	4	5
I feel confident that I can provide treatment based on the principles of motor learning	1	2	3	4	5
I feel that I need a lot of training in motor learning in order to be able to use this approach in my practice.	1	2	3	4	5
I feel that I can explain to someone else the difference between giving instructions using "external focus of attention" compared to an "internal focus of attention".	1	2	3	4	5
I feel confident in my ability to explain to someone else the concept of variability of practice.	1	2	3	4	5
I feel confident in my ability to explain to someone else the concept of random order of practice versus blocked or serial order of practice.	1	2	3	4	5
I feel confident in my ability to explain to someone else what are the two types of feedback: "knowledge of results" and "knowledge of performance".	1	2	3	4	5

(*Continued*)

(Continued).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel confident in my ability to explain to someone else the relationship between the extent of repetitions within practice and motor learning.	1	2	3	4	5
I feel confident in my ability to explain to someone else the practical meaning of the term positive reinforcement (reward) in the context of motor learning.*	1	2	3	4	5
I feel confident in my ability to explain to someone else the components that make practice specific.	1	2	3	4	5
I have no difficulty implementing the principles of motor learning in physical therapy treatments.	1	2	3	4	5
I feel confident in my ability to teach physical therapy students how to use motor learning principles in their treatment.	1	2	3	4	5

* Note: The original phrasing of this item was: "I am confident in my ability to explain to someone else the difference between feedback and reward in the context of motor learning."

Part B: Self-reported Implementation of motor learning principles.

Please respond to the following questions by circling the number that best describes you. Please complete all items and mark "I am not aware of this element of ML" only as your last resort.

	Very little	A little	To some degree	A lot	Very much
To what extent does your practice involve motor learning?	1	2	3	4	5
To what degree do you implement the principles of motor learning in your practice?	1	2	3	4	5

If you do not use the principles of motor learning at all, please skip to question 11

	Very little	A little	To some degree	A lot	Very much	Unaware
To what degree do you plan whether to give instructions using "external focus of attention" or "internal focus of attention"?	1	2	3	4	5	I am unaware of this ML element
To what degree do you use variability of practice?	1	2	3	4	5	I am unaware of this ML element
To what degree do you modulate environmental factors and motor demands to generate challenge during practice?	1	2	3	4	5	I am unaware of this ML element
To what extent do you plan whether the feedback you give will be based on "knowledge of results" or "knowledge of performance"?	1	2	3	4	5	I am unaware of this ML element
To what extent do you plan the timing and frequency of the feedback?	1	2	3	4	5	I am unaware of this ML element
To what extent do you attribute importance to the amount of practice (i.e. repetitions)?	1	2	3	4	5	I am unaware of this ML element
To what extent do you structure the number of repetitions within a practice?	1	2	3	4	5	I am unaware of this ML element
To what extent do you include positive reinforcement (reward) in the learning process?	1	2	3	4	5	I am unaware of this ML element
To what extent do you use outcome measures to monitor the learning process?	1	2	3	4	5	I am unaware of this ML element
To what extent do you structure your practice to be specific?	1	2	3	4	5	

Part C: General attitudes and perception about the workplace environment

	Very little	Small degree	Moderate degree	Large degree	Very much
To what extent do you dedicate time planning the practice variables (e.g. order of practice, frequency of feedback)?	1	2	3	4	5
At your workplace, to what extent you are given enough time to treat patients according to the principles of motor learning.	1	2	3	4	5
I can consult with my peers at my workplace about giving motor-learning based treatment.	1	2	3	4	5
To what extent do physical therapists in your field use the principles of motor learning?	1	2	3	4	5

Do you think there are barriers to implementing the principles of motor learning in physiotherapy? Yes/No
If yes, please specify.

____-
____-
____

Please list treatment methods in physical therapy you know that are based on motor learning.

____-
____-
____

Thank you for your cooperation!