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Original Article

Adaptation and Validation of the Learning-Specific Inner Speech Scale (LISS) to the Motor Learning Context

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Abstract

Introduction: The development of tools to measure self-talk is very important, and sports psychology researchers have designed and tested numerous questionnaires in different fields.
Objective: Due to the lack of appropriate tools for assessing frequency and content of inner speech when learning new motor skills, this study was designed to modify the Learning-Specific Inner Speech Scale (LISS) (Xiang et al. 2020) into the motor learning context. We evaluated the quality of the modified version of the scale (i.e., the Motor Learning-Specific Inner Speech Scale, MLISS) by examining its factor structure, internal consistency, and content validity among adolescents.
Methods: This study used a correlational method using a structural equation modeling. The participants were 312 adolescents (150 girls), who completed the MLISS, consisted of 16 items which measures four dimensions of inner speech including self-criticism, self-reinforcement, self-management, and social assessment. Confirmatory factor analyses and structural equation modelling were used for data analysis.
Results: Confirmatory factor analysis supported the hypothesized structure of the measure in adolescents.
Conclusion: The results provide evidence that the modified scale is valid in assessing frequency of inner speech use in motor learning. The development of the MLISS extends, for the first time, an extant measure of inner speech to the motor learning context.

Keywords: Inner Speech, Motor Learning, Self-Talk, Scale, Validation

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1. Introduction

A motor skill is basically the ability to activate some body muscles to achieve a specific goal or outcome. A general classification of motor skills includes gross motor skills (which require the movement of the whole body and include large muscles such as standing, walking, running, grabbing, jumping, and sitting straight) and fine motor skills (which involve the use of small hand muscles such as when picking up small objects like rosary beads or pieces of paper or cutting things with scissors) (1). There is a general belief that motor skills are acquired through overt physical practice and repetition of skill performance. However, evidence has shown that specific cognitive strategies can promote motor skill learning with or without actual physical practice. One of the most common strategies used for learning new motor skills is self-talk. Self-talk refers to words or sentences addressed to the self, said either aloud (private speech) or silently (inner speech). In the sport context, self-talk can be phrased positively or negatively, have an instructional or motivational purpose, and be strategic or goal-directed (2- 9).

Numerous studies have examined the effects of self-talk on motor performance (i.e., a temporary status of motor behavior, for example assessed during a motor practice session) and motor learning (i.e., relatively stable changes of the capability to perform a motor task related to practice and aimed interventions) (10-16). In a meta-analysis, Hatzigeorgiadis et al., (17) found that instructional self-talk (e.g., "ball … step … swing") is more effective than motivational self-talk (e.g., "I can do this") for precision and outcome-based motor skills (e.g., e.g., dart throwing, golf-putting, shooting in basketball), while the opposite was observed for motor skills requiring physical conditioning, endurance, and strength (e.g., cycling, long distance running, long-jump, shot-put). Research proposes that self-talk affects information processing and attention (i.e., a cognitive mechanism), self-efficacy and effort (i.e., a motivational mechanism), emotion regulation (i.e., an affective mechanism), and movement pattern and effortless performance (i.e., a behavioral mechanism) (see 6 for more detail).

It is not clear when and why novices use self-talk during the motor learning process. One possible reason may be that there are no appropriate tools for assessing frequency and content of internal speech when learning new motor skills. Otherwise, use of self-talk has been studied in athletes, and there are validated tools such as Self-Talk Use Questionnaire (18)

and Automatic Self-Talk Questionnaire for Sports (19), which examine several aspects of using self-talk (e.g., when, what, why) in athletic sports. Nevertheless, this issue has not been studied in the field of inner speech in motor leaning. However, to the best of our knowledge, there are no appropriate tools for assessing inner speech when learning new motor skills.

Intrapersonal communications can occur in several ways such as self-talk and inner speech. Theory and research in this area highlights the self-regulatory functions of inner speech (e.g., 20-22). The Self-Talk Scale (23) assesses people's typical self-talk in response to a variety of everyday events or circumstances. It measures four specific functions-self-criticism, self-reinforcement, self-management, and social assessment. Self-criticism encompasses self-blaming talk when one feels discouraged by negative daily experiences; self-reinforcement focuses on talking to oneself when positive daily events happen; self-management pertains to self-regulation and directing one's behavior, and social assessments refers to one's social interactions (24). Whereas the Self-Talk Scale (STS) measures people's self-talk frequency in response to general situations, researchers have created adapted versions of the measure to study specific behavioral contexts, such as public speaking (25)

Recently, Xiang et al. developed the Learning-specific Inner Speech Scale (LISS) used for assessing students spanning a broad range of ages. The LISS takes a functional view of inner speech, assessing the frequency of social-assessing, self-critical, self-reinforcing, and self-managing inner speech within specific learning and academic contexts. Conducting three studies based on child, adolescent, and young adult samples, Xiang et al. demonstrated that the LISS exhibits acceptable psychometric properties in terms of internal consistency, test-retest reliability, and construct and content validities. In addition, the LISS is age-sensitive and demonstrates a favorably predictive validity for students' real-life learning performance. Xiang et al. concluded that the LISS provides researchers and practitioners with a useful tool for exploring verbal thinking and its relationships with learning strategies and performance. However, the academic learning environment is different from motor skills learning, because learning motor skills relies mainly on the motor and cognitive abilities of learners, while academic skills are mainly cognitive in nature.

In summary, there are no appropriate tools for assessing inner speech when learning new motor skills. Due to the importance of inner speech in sport (2-9), in the present studies, we aimed to modify the LISS into the motor learning context and then, evaluate the quality of the modified version of scale by examining its factor structure, internal consistency, and content validity among adolescents. Hence, we aimed to explore the reliability and validity of the new measure in adolescents.

2. Methods

This study used a correlational method using a structural equation modeling.

2.1. Participants

The sample included 312 adolescents (150 girls) aged 14 to 17 years from middle and high schools in Tehran, Iran. Using a sample size calculation appropriate for correlational studies with α=0.05, β=0.05, and r=0.20, the appropriate sample size was determined to be 312 individuals. Parents gave written informed consent to take part. Participants completed the MLISS individually in a quiet classroom with paper and pencil.

2.2. Measure

In the present study, we modified the LISS (24) for the motor learning context. The LISS focuses on the frequency and content of inner speech in learning-specific contexts such as taking academic examinations, doing schoolwork, or interacting with teachers or classmates. The original LISS contains 16 items and measures four dimensions of inner speech or silent self-talk (self-criticism, self-reinforcement, self-management, and social assessment), with four items tapping each dimension. Each item is rated on 5-point frequency scale (1 = *never*, 5 = *very often*), using the common stem "I talk to myself silently when…". To modify the LISS for the motor learning context, we reworded the items of the LISS for each of the four dimensions. For example, the item of "I should have done differently in solving a problem or reading a book" (self-criticism) was revised into "I should have done differently in performing a motor skill". We named the modified scale as the Motor Learning-specific Inner Speech Scale (MLISS).

The present study used Wild et al.'s (26) model for translating and validating the MLISS. First, the MLISS was translated to Persian. Two translators with high competency in both English and Persian translated the MLISS to Persian. The two translations were compared and contrasted, and then merged into one final translation. Then, the MLISS was piloted with a group of young children (n = 41, aged 7–8 years) to assess whether the wording was understandable. This process resulted in some minor revisions to the items. All items of the scale were regarded as understandable and appropriate for students over 7 years of age. In the next step, the final version of the Persian-MLISS was translated to English by two competent translators who had no contact with the first translators. The two translations were compared with the original MLISS by a lead translator and confirmed.

The final version of the MLISS (see Appendix) consists of 16 items and assesses the same four dimensions as the LISS including self-criticism (e.g., I feel ashamed or guilty about my performance in learning a motor skill), self-reinforcement (e.g., I feel good about my performance in learning a motor skill), self-management (e.g., I want to explore how to learn a motor skill), and social assessment (e.g., how my instructors or teammates will respond to what I have performed). We also revised the instructions for completing the measure to reflect the motor learning context.

2.3. Data Analysis

Internal consistency reliability was measured using Cronbach's alpha. Correlations between subscales were calculated using the Pearson correlation test. Construct validity of the MLISS was assessed using confirmatory factor analyses (CFA) in Lisrel® version 10.2. Maximum likelihood estimation was used to assess model fit, using a variety of fitness indices as recommended in the literature (27,28). The most important fitness

indices used included Chi-square, SRMR, NNFI, CFI, IFI, and RMSEA (29). We assessed the assumptions of maximum likelihood estimation before conducting the CFA.

3. Results

Table 1 describes the MLISS subscales and total score and also shows the correlation between the subscales for the adolescent sample. There were positive and significant correlations between all subscales and also between the subscales with the total score among (all ps < 0.001). Moreover, Cronbach's alpha results show that all values are above the acceptable value of 0.70 (see Table 2).

Table 1. Descriptive Statistics and Correlation between Subscales.

Measure		M	SD	1	2	3	4	5
Adolescents (N=312)	1. Total Score	52.93	12.4	-	0.74**	0.75**	0.81**	0.68**
	2. Self-Criticism	12.79	3.9	-	-	0.29**	0.41**	0.53**
	3. Self-Reinforcement	13.96	4.1	-	-	-	0.71**	0.22**
	4. Self-Management	13.62	4.2	-	-	-	-	0.29**
	5. Social Assessment	12.54	4.3	-	-	-	-	-

Table 2. Cronbach's Alpha Results.

	Measure	Cronbach's Alpha
Adolescents	Self-Criticism	0.80
	Self-Reinforcement	0.87
	Self-Management	0.87
	Social Assessment	0.82

We conducted a confirmatory factor analysis with four subscales as latent variables and 16 items. The results of exploratory factor analysis with SPSS software showed that the value of the KMO statistic is equal to 0.91, which is higher than the standard of at least 0.5. Therefore, the sample size is sufficient for factor analysis. Also, Bartlett's test is also significant (p=0.000, χ=2.4957), that is, the correlation between variables is significantly different from zero. The results of factor analysis on 16 items with varimax showed that according to the Kaiser criterion (eigenvalues higher than 1), four factors were identified in Table 2 and explained 68.25% of the variance (Table 3).

Table 3. Eigenvalues.

Factor	Total	Relative Variance	Cumulative Variance
1	2.91	39.38	39.38
2	2.84	16.46	55.84
3	2.71	6.6	62.45
4	2.45	5.79	68.25

Table 3 shows the matrix of rotated factor loadings, items with high loading on one factor form four factors. The first factor (SM) includes questions 3-12-9-15; The second factor (SR) includes questions 8-2-5-13; The third factor (SA) included questions 4-6-11-16 and the fourth factor (SC) included questions 1-7-10-14 (Table 4).

Table 4. Factor Loadings of Each Item.

Item	SM	SR	SA	SC
15	0.796			
12	0.790			
9	0.777			
3	0.775			
8		0.810		
2		0.774		
5		0.772		
13		0.725		
4			0.774	
6			0.769	
11			0.756	
16			0.736	
14				0.822
10				0.744
7				0.687
1				0.649

The results (see Table 5 and Figure 1) also showed that the initial model with four factors (self-criticism, self-reinforcement, self-management and social assessment) had a favorable fit. The second model includes two hidden factors including positive function (items related to self-reinforcement and self-management) and negative function (items related to self-criticism, and social assessment) of inner speech. The CFT results showed that the model has a very good fit. Finally, a second-order CFT was performed with four factors in the first order (self-criticism, self-reinforcement, self-management and social assessment) and inner speech in the second order (total). The results showed that the final model also has a good fit in both age groups. Therefore, the MLISS has appropriate construct validity and structure.

Table 5. Results of Fiting Structural Questionnaire Models Based on Data from Adolescents.

Adolescents (N=312)	X2	df	RMSEA	CFI	IFI	NNFI	SRMR
Final Model(Two-Order)	312.61	100	0.06	0.95	0.95	0.94	0.09
Two-Factor Model (One-Order)	400	103	0.09	0.88	0.88	0.85	0.067
Four-Factor Model (One-Order)	134.8	98	0.035	0.98	0.98	0.98	0.027

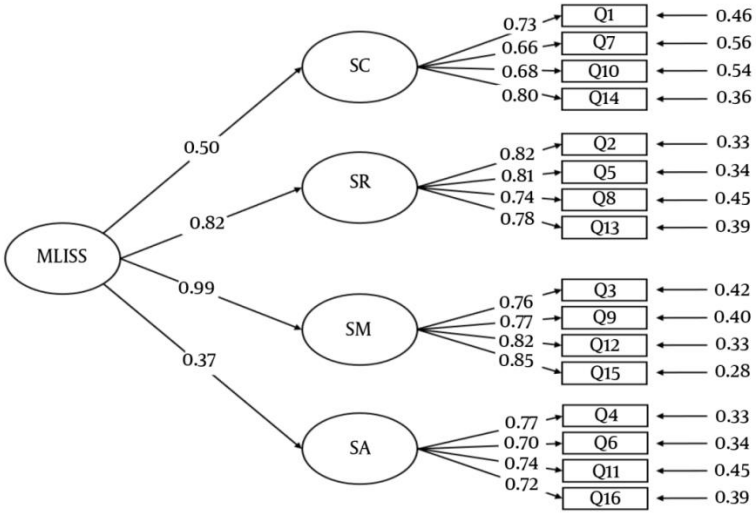

Figure 1. b-Values in Adolescents.

4. Discussion

Due to the lack of appropriate tools for assessing the frequency and content of inner speech when learning new motor skills, this study was designed to modify the LISS (24) into the motor learning context and then, evaluate the quality of the modified version of scale (i.e., MLISS) by examining its factor structure, internal consistency, and content validity among adolescents. Results supported the reliability and validity of the new measure for adolescents. In the remainder of this section, we discuss ways that the MLISS might be useful in future research.

Regarding the subscales of the MLISS (self-criticism, self-reinforcement, self-management, and social assessment), it should be noted that these dimensions have not previously been investigated in the motor learning context. In fact, previous self-talk tools such as the Self-Talk Use Questionnaire (18) and the Automatic Self-Talk Questionnaire for Sports (19) examined several aspects of using self-talk (e.g., when, what, why) in athletic sports; however, the subscales of the MILSS offer new aspects of inner speech in the motor learning context. Though mistakes are common during the initial stages of learning novel motor skills, the self-blaming talk and criticism that learners experience when they make mistakes may make them feel a diminished sense of self and emotional distress following poor performance. Past research (20) suggests that self-talk frequency increases with instances of cognitive or emotional disruption, and this should occur when learning a new motor task.

It is necessary to examine the self-criticism function of inner speech when learning new motor skills. In the real world, learners practice new motor skills mainly in front of their teammates or other learners, and this can put much pressure on the learners when they show performance errors and subsequently increases the possibility of their using self-critical inner speech. On the other hand, the self-reinforcement function of inner speech focuses on positive results when learners perform a novel motor skill well. In the real world, self-reinforcing self-talk may occur when novices perform novel motor skills very well, particularly when they gradually progress in practicing that skill.

The self-management function of inner speech, which pertains to self-regulation and directing a learner's behavior, can also be a very important aspect of inner speech while learning a novel motor skill. In fact, research on the effects of self-talk on motor learning and sport performance suggests that self-talk helps cognitive and motor self-regulation (6). It can be assumed that inner speech helps cognitive and motor self-regulation in novices when they learn novel motor skills. Due to the self-regulatory function of the self-management dimension of inner speech, it can be a very important aspect of inner speech during the motor learning process.

Finally, social assessment, which refers to a learner's social interactions such as replaying something said to another person or imagining how other people responded to the learner's performance, happens regularly while practicing or performing motor skills. Novices are frequently receiving feedback from instructors or other learners during practice, and they can also respond silently to feedback from others on their teammates' performances. Therefore, evaluating the social assessment dimension of inner speech is also potentially very important when learning motor skills. Taken together, the MLISS provides, for the first time, a validated tool for assessing the frequency of four functional dimensions of inner speech use during the motor learning process.

A limitation to this study was that we used only adolescents as statistical sample. Future studies may include children into the sample to calculate age differences regarding the effects of inner speech in motor performance. In addition, this study was performed cross-sectionally, which prevents the determination of causality. Future studies may consider experimental design for investigating the effects of using inner speech in motor performance and learning in children and adolescents. As a strength of this study, it can be stated that an inner speech scale

was validated for using in adolescents for the first time.

4.1. Conclusion

In conclusion, the results of first study revealed that the MLISS is reliable and valid for assessing motor learning-specific inner speech of adolescents. Our data show that the MLISS and its four dimensions (self-criticism, self-reinforcement, self-management, and social assessment) exhibit acceptable psychometric properties in terms of internal consistency reliability and construct validity. The development of the MLISS extends, for the first time, an extant measure of inner speech to the motor learning context and allows advances in studying the effects of inner experiences in adolescents. Practically, the scale may provide instructors with assessment tools to develop targeted interventions that facilitate motor learning in novices.

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Footnotes

Authors' Contribution: Study concept and design: B. T; D. A. Acquisition of data: D. A. Analysis and interpretation of data: D. A; GH. S. Drafting of the manuscript: D. A; GH. S. Critical revision of the manuscript for important intellectual content: B. T. Statistical analysis: GH. S. Administrative, technical, and material support: B. T. Study supervision: B. T.

Conflict of Interests: The researcher confirms that there is no conflict of interests in this study with any participant.

Data Availability: The data that support the findings of this study are openly available upon request from the corresponding author.

Ethical Approval: Approval for this study was obtained from the university. The author confirms that all steps . The requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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Appendix

The Motor Learning-specific Inner Speech Scale (MLISS)

Instruction

Have you ever talked to yourself silently in your motor learning activities? For example, when you learn a Tennis serve, you may talk silently to yourself like "I am doing great." When you perform badly on a test because of carelessness, you may say silently to yourself "be cautious next time." We would like to know something about your inner thoughts during your motor learning activities. You will be asked to evaluate how often you talk to yourself silently in various motor learning scenarios.

Please rate each of the items by using the following response scale: 1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = very often.

1. I talk to myself silently when I should have done differently in performing a motor skill. [SC]
2. I talk to myself silently when I achieve a high score in a test. [SR]
3. I talk to myself silently when I want to explore how to learn a motor skill. [SM]
4. I talk to myself silently when I consider how my instructors or teammates will respond to what I have performed. [SA]
5. I talk to myself silently when I feel good about my performance in learning a motor skill. [SR]
6. I talk to myself silently when I want to analyze what my instructors or teammates recently have said to me. [SA]
7. I talk to myself silently when I feel ashamed or guilty about my performance in learning a motor skill. [SC]
8. I talk to myself silently when I am proud of my performance in learning a motor skill. [SR]
9. I talk to myself silently when I am mentally exploring an appropriate method for learning a motor skill. [SM]
10. I talk to myself silently when I am really upset with my test results. [SC]
11. I talk to myself silently when I guess what my instructors or teammates will say to me and consider how to respond to or respond to their feedback. [SA]
12. I talk to myself silently when I instruct myself regarding what I should learn. [SM]
13. I talk to myself silently when I encourage myself to do better in my motor tasks. [SR]
14. I talk to myself silently when I encounter bad things in my motor tasks such as "I haven't performed correctly the assigned motor tasks." [SC]
15. I talk to myself silently when I remind myself of completing a learning motor task. [SM]
16. I talk to myself silently when I replay what an instructor or a teammate has said to me. [SA]

Notes. SC = Self-Criticism; SR = Self-Reinforcement; SM = Self-Management; SA = Social-Assessment.