The effects of a Feldenkrais program and relaxation procedures on hamstring length

Despite the growing popularity of the Feldenkrais method in Australia (Wildman 1990b), little research is available investigating its efficacy. The current study investigated the effects of the Feldenkrais method on hamstring length. Forty-eight healthy undergraduate participants were randomly allocated into either Feldenkrais, relaxation, or control groups. All subjects had their right hamstring measured using a modified active knee extension test prior to the first session, prior to the fourth (final) session, and after the final session of intervention. Two-way analysis of variance with time of measurement repeated revealed no significant differences between the groups. The findings are discussed in relation to apparent ineffectiveness of the Feldenkrais awareness through movement lessons used on hamstring length, exposure time to the technique, and attitudes towards the Feldenkrais method.

Extensive research can be found in the literature investigating the detrimental effects of hamstring muscle tightness (Sutton 1984). Several conditions commonly seen by physiotherapists have been linked to hamstring muscle tightness. These include hamstring strain (Sullivan et al 1992), spinal dysfunction (O’Callaghan 1990), and patellofemoral joint pain (Smith et al 1991).

In order to address the issue of hamstring tightness, both to screen for reduced extensibility and to assess effects of treatment, a reliable and valid measuring tool should be used. A review of recent literature identified several tests used to assess hamstring length. Despite the high intra-tester and inter-tester reliability of these tests (see Gajdosik et al 1993, Worrell et al 1992), most have been criticised for their poor validity. For example, Bohannon (1982) reported that a large amount of pelvic rotation occurs during the passive straight leg raise (SLR) test. If this movement is not taken into account, an invalid measure will be recorded. In addition, Gajdosik et al (1990) found that, in a sample of 30 normal subjects, pain limited passive straight leg raise, and Urban (1981), in his review of the literature, reported that this pain arose mainly from neural structures rather than the hamstring muscle group itself.

Similarly, the sit-and-reach and toe-touch tests have also been criticised. They have been seen as only providing a gross indication of hamstring length, involving not only hip and knee movement, but also vertebral and ankle movements (Kane and Bernasconi 1992). With certain subjects, these two tests would be limited not by the

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The sample of 27 normal subjects, only 9.6 invalid measure of hamstring length. In comparison, the active knee extension test (AKE) exhibits greater control of extraneous joint movement, especially at the pelvis. Kane and Bernasconi (1992) reported that, in a sample of 27 normal subjects, only 9.6 degrees of posterior pelvic rotation occurred during the AKE when the contralateral hip was in neutral and no external strapping was used. This can be compared with the 25 degrees (mean) of rotation reported by Bohannon (1982) for the passive SLR test on 11 normal subjects when using three different methods of pelvic and lower limb strapping. In addition, Kane and Bernasconi (1992) reported that pelvic stabilisation could be further improved by positioning the contralateral hip in maximal flexion, resulting in only 5.5 degrees of pelvic rotation. Intra-tester reliability (ICC = 0.93, Worrell et al 1992) and inter-tester reliability (correlation coefficient = 0.94, Kane and Bernasconi 1992) have been found to be high for these versions of the AKE test. Unfortunately, there is little literature investigating the effect of the AKE test on neural structures, with this being a much needed area for further research. Assuming that these structures do not greatly limit the AKE test, it can be argued that the AKE test is the most valid of the tests reported for measuring hamstring length, simply due to its more effective stabilisation procedures.

A technique which has been claimed to increase hamstring length is the Feldenkrais method (Wildman 1983c). Usage of the Feldenkrais method has increased in recent times, with Wildman (1990a) estimating in 1986 that more than 500 Australian physiotherapists had undergone Feldenkrais training in the previous four years.

The Feldenkrais method aims to retrain a person to learn to move in a more efficient manner. That is, without superfluous movement or muscle contraction which may interfere with or oppose the desired movement (Feldenkrais 1984, Lake 1985). The technique comprises two parallel modes: functional integration and awareness through movement (ATM). Functional integration has been described as a "... one-to-one learning process where the practitioner communicates new possibilities of body organisation using gentle and non-invasive guidance" (Scoglio 1993, p. 4). The second technique, ATM, consists of "... verbally directed movement sequences that are presented primarily to groups" (Scoglio 1993, p.4).

Both forms of the Feldenkrais method involve the performance of simple movement patterns conducted in a slow manner, without pause, and short of any discomfort or pain. The participant focuses on how the body moves, exploring the connection between body parts and how a specific movement has been accomplished (Wildman 1990b). It has been suggested (Lake 1985) that this results in increased awareness which gradually extends beyond the prime movers, allowing the recognition that only minimal spatial reorganisation is necessary to result in increased mobility. Through presenting the participant's brain with alternative movements, it is argued that the brain will choose the most desirable movement, namely the one with the most efficiency (Dornan 1990). Furthermore, Morris (1992) has stated muscle relaxation to be an integral part of the Feldenkrais method. Of interest, Bullock-Saxton and Bullock (1994) have proposed muscle relaxation to be a possible source of error during muscle length measurements, which may form a possible explanation for any muscle lengthening following Feldenkrais method intervention.

Relatively few studies have been published that have investigated the effects of the Feldenkrais method; the majority of these have been in the form of case studies and anecdotal evidence (Lake 1985, Rosenfeld 1992). In fact, only five empirical studies were found in the literature investigating this technique. These studies have produced mixed findings which were often complicated by poor methodology and assessment, such as lack of control groups (Brown and Kegerreis 1991) and inappropriate use of statistical tests (Ruth and Kegerreis 1992), not to mention the obvious difficulties of investigating this area where dependent variables are affected by multiple physical, psychological, and autonomic influences. Of note, no studies were found in the literature which assessed the effect of the Feldenkrais method on hamstring muscle length. For these reasons, the present work was conducted within an exploratory framework.

The aim of this study was two-fold. First, to investigate the effects of an ATM program on hamstring muscle length. It was hypothesised that the ATM program would significantly increase hamstring muscle length. Second, to identify variables that need to be addressed and tightly controlled in further quantitative investigation of the Feldenkrais method.

Method

Subjects

The participants were 48 normal undergraduate university students. Initially, 62 subjects were recruited; 59 (36 female and 23 male) were enrolled in a physiotherapy course and three (one female and two male) were enrolled in other tertiary courses. Prior to involvement in the study, participants were screened for high hamstring extensibility for which the modified AKE test would not be indicative of hamstring muscle length. In this case, participants could complete the full range of knee extension, and were limited from further movement by structures other than the hamstring muscle. Eight subjects were excluded for this reason. Of the participants who commenced the study, six failed to complete all sessions due to outside commitments, injury, illness, or forgetting to turn up to sessions. This left a final sample of 48, a retention rate of 89 per cent. In
total, 28 females (mean (SD) age 21.8 (4.5) years) and 20 males (mean (SD) age 21.8 (2.9) years) completed the study. Participants were randomly allocated to one of three groups: Feldenkrais (n = 14, mean (SD) age 23.1 (5.1) years), relaxation (n = 17, mean (SD) age 21.3 (4.2) years), or control (n = 17, mean (SD) age 21.3 (1.9) years). Prior to the commencement of the study, all subjects answered a questionnaire which included listing prior Feldenkrais experience.

Tests
A cross-rod apparatus was constructed using a metal rod, consisting of a 55cm horizontal section and a 96cm vertical section. This was attached to the metal undercarriage of a firm, standard plinth via a "G" clamp and a laboratory clamp. An 18cm arm and a 9.5cm arm standard goniometer were used for the measurement of joint angles.

The method used to measure hamstring length (Figure 1) was based on the AKE test procedure described by Gajdosik and Lusin (1983). In line with the recommendations of Kane and Bernasconi (1992), the AKE test was modified. This involved placing the contralateral hip in maximal flexion to decrease pelvic movement (no strapping was used), and defining the end of range as the point of maximal knee extension. No warm up was performed prior to test procedures.

Points were marked on each participant's right leg following the recommendations for this procedure reported by Gogio et al (1987); centre of the greater trochanter, centre of the lateral condyle of the femur, and the centre of the lateral malleolus. The participant's hip was passively flexed to 90 degrees from full extension (Figure 1). The angle of hip flexion was checked with the large goniometer and both the participant's hip and the cross-rod were positioned accordingly until 90 degrees hip flexion was obtained.

The participants were instructed to keep their right foot relaxed in order to reduce the risk of neural tension limiting range of movement (Gajdosik et al 1993), to keep their left hip maximally flexed, and to maintain the contact between the cross-rod and their thigh. The participant then actively extended their right knee as far as possible, defining the end point of motion (Kane and Bernasconi 1992). All subjects reported a subjective feeling of tension in the hamstring region at the end point of motion. The degree of knee extension was measured using a goniometer according to the procedures of Gogio et al (1987), which have been reported to have high inter-tester reliability (ICC = 0.99) and validity (ICC = 0.98 - 0.99). The angle recorded reflected the number of degrees from full extension (Figure 1).

The above procedure was repeated a further two times on the right leg, with the mean of these three measurements used in data analyses. Following the recommendations of Worrell et al (1992), one of the investigators acted as sole tester during the study, and was blinded as to which group subjects were allocated.

A prior pilot study by the investigators demonstrated that the tester had high test-retest reliability (Pearson product moment coefficient) when using this method for measuring hamstring length over a 30-minute period (n = 10, r = 0.93).

Treatment procedures
In addition to the Feldenkrais group, a relaxation and a no treatment (control) group were included in the study, to investigate whether any possible change in hamstring length could be attributed simply to muscle relaxation or practice effects.

Subjects in the Feldenkrais and relaxation groups participated in four 45-minute lessons over a two-week period. For participants in the Feldenkrais group, this consisted of four different ATM lessons recorded on audiocassette: "Activating the Flexors" (Wildman 1983b); "Activating the Extensors" (Wildman 1983a); "Rolling Onto the Side" (Wildman 1983d); and in the fourth session, "Lengthening the Hamstrings and Spine" (Wildman 1983c). Participants in the relaxation group listened to a relaxation training audiocassette (Kirkby 1994) comprising aspects of Benson's relaxation (Benson et al 1977), Jacobson's relaxation (Jacobson 1938), and guided imagery (Clark and Jackson 1983).

Right hamstring length was assessed on all subjects using the above method on three occasions: prior to the first session (Test 1); prior to the fourth session (Test 2); and on completion of the fourth session (Test 3). This enabled the assessment of any change in hamstring length over three and four sessions, and over the final 45-minute session (Session four). Participants in the control group did not participate in any supervised lessons, but were required to attend all measurement sessions. Over the testing period, these subjects were asked not to alter their exercise habits. In the time between Test 2 and Test 3, subjects were asked to refrain from exercise or placing themselves in hamstring lengthening positions (eg sitting with knees extended). This was necessary as muscle length has been shown to be affected during, and for more than 90 minutes after exercise and muscle stretching have ceased (Shellock and Prentice 1985).
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Statistical methods.

Prior to analyses, data were examined for accuracy of entry, missing values, fit between their distributions, and the assumptions of ANOVA. No values were found to be missing, data were normally distributed, and the assumptions of ANOVA were not violated.

Two-way ANOVA with one factor repeated (SuperANOVA, Statview SE® + Graphics) identified effects of group, treatment, and time of testing. A second three-way ANOVA with one factor repeated examined the effects of gender.

A simulation (within group standard deviation = 10 degrees) was conducted to determine the power of the design. A Type 1 error level of $\alpha < 0.1$ was adopted in light of the exploratory nature of the current investigation. In the simulation, increments of 5 degrees of mean knee extension range were considered to be clinically significant (Relaxation: Test 1 - 30 degrees, Test 2 - 25 degrees, Test 3 - 20 degrees; Feldenkrais: Test 1 - 30 degrees, Test 2 - 25 degrees, Test 3 - 10 degrees; Control: Test 1 - 30 degrees, Test 2 - 25 degrees, Test 3 - 30 degrees). The power of the design to detect a main effect of group was 68 per cent (Cohen 1988).

Results

No significant differences were found between treatment groups, $F_{(5,47)} = 0.32, p = 0.73$, the measurement times, $F_{(2,47)} = 1.85, p = 0.16$, or as an interaction effect, $F_{(4,45)} = 1.46, p = 0.22$. Although a trend was present in the Feldenkrais group for an increase in hamstring length over the final measurement ($p = 0.16$), the degree of change was statistically and clinically insignificant (Table 1).

Analysis of the effect of gender also yielded no significant findings. No significant difference was found between gender and treatment group, $F_{(3,45)} = 0.49, p = 0.78$, or between gender and time of measurement, $F_{(10,42)} = 1.35, p = 0.09$.

Discussion

The findings of the current study indicated that the Feldenkrais intervention was not effective in increasing hamstring length when compared with relaxation procedures or no treatment. Further, gender was found to have no significant influence on the findings of this investigation.

Due to the limited amount of research into the Feldenkrais method, it is difficult to compare these results with previously published literature. As outlined above, this is the first published study which addressed the effect of the Feldenkrais method on hamstring length. The research which has been published on the Feldenkrais method generally has had problems with methodology and assessment, further confounding any comparison.

Separate from the above statements, there are three factors which could have contributed to the lack of significant findings and are possible areas that need to be addressed and tightly controlled in further research. First, Feldenkrais subjects may not have experienced sufficient ATM lessons to derive benefit from them. Once again, no research (in general, or in relation to hamstring length) has been undertaken in this field, although statements have been made by Feldenkrais practitioners opposing this argument. For example, Lake (1985) claimed that “positive result” in improving standing posture may be obtained within a single session of Feldenkrais, and that subsequent reinforcement will ensure that learning continues to take place. He continued with a report on the case studies of six patients with acute back pain who, it was claimed, achieved positive results (p. 1175) after one Feldenkrais session. Although photographs were taken of patients pre- and post-treatment, no objective measures were taken and there were no definitive times for post-treatment photographs to be taken.

Second, the preconceived ideas of subjects towards Feldenkrais could have influenced the findings. All subjects in the Feldenkrais group had previously been exposed to this method as part of their undergraduate physiotherapy course. Several of these participants (approximately four of the 14) commented that they believed the Feldenkrais method to be of no worth as a treatment technique. This may have affected their personal involvement during lessons. For example, they could have conducted the required movements but undertaken no active awareness of how they were moving. As stated by Feldenkrais (1992), a lack of awareness affects the efficiency of a Feldenkrais lesson, and in turn, could have contributed to the lack of significant change in the current investigation.

The third factor is based on the different motor patterns required in the final ATM lesson compared with those required for the outcome measure (the modified AKE test). The active component of Wildman's (1983c) “Lengthening the Hamstrings and the Spine” ATM lesson involves

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Pre-session 1 Hamstring Measurement</th>
<th>Pre-session 4 Hamstring Measurement</th>
<th>Post-session 4 Hamstring Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feldenkrais</td>
<td>31.88 (2.53)</td>
<td>33.50 (2.41)</td>
<td>30.57 (2.57)</td>
</tr>
<tr>
<td>Relaxation</td>
<td>35.27 (3.34)</td>
<td>34.65 (3.17)</td>
<td>34.88 (3.41)</td>
</tr>
<tr>
<td>Control</td>
<td>30.63 (2.16)</td>
<td>34.41 (2.56)</td>
<td>33.00 (2.49)</td>
</tr>
</tbody>
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*mean in degrees (standard error)
mainly rhythmically massaging down the legs while positioned in long sitting. The modified AKE test is quite different from this action, strictly controlling movements in the supine position. It has been claimed that the Feldenkrais method partially works through the utilisation of different motor patterns during a movement (Dornan 1990), in this case those explored in the ATM lesson. By testing with the modified AKE test, a new action and therefore a new motor pattern would need to be explored and established to result in increased range. Further, restrictions were placed on the lumbar, pelvic, and hip movements during the hamstring testing, abolishing possible learning which may have utilised these parts of the body to aid in lengthening the hamstrings during the ATM lesson. As discussed above, however, testing the hamstrings in a position more similar to the "Lengthening the Hamstrings and the Spine" ATM lesson (eg sit-and-reach test) only grossly assesses hamstring length (Kane and Bernasconi 1992). Therefore, despite the need for the utilisation of different motor patterns in the modified AKE test, this method ensured greater validity of testing procedures.

The findings of this study have identified variables that need to be tightly controlled in further quantitative investigation of the Feldenkrais method. As discussed above, subjects in the Feldenkrais group may not have experienced enough ATM lessons to derive benefit from them, and the effectiveness of these lessons could have been influenced by preconceived ideas on the Feldenkrais teachings. Further research should perhaps assess a population who have had no prior exposure to the method. As well, it is worth considering whether a test that measures hamstring length in relative isolation from a functional movement pattern (as encouraged in Feldenkrais) is an appropriate way to assess the effectiveness of the Feldenkrais method. It appears that a more functional outcome measure may be a better indicator of the efficacy of the Feldenkrais method. Finally, the present results do offer some support for possible effectiveness of the Feldenkrais method. Application of the only condition predicted to change the knee extension range (the ATM "Lengthening the Hamstrings") was associated with the largest change observed in the experiment (3 degrees), and the change was in the predicted direction. It is possible that this trend represented an effect which did not reach statistical significance because it was embedded at the level of a first order interaction, where the power was very low. Given the variability in data of this type (group standard deviations ranged from 14 degrees to 9 degrees), and the small size of the apparent effect, future investigations should be designed to utilise larger sample sizes, and test at the level of main effects.

Despite the limitations of the study, this research has been important in the continuing development of knowledge in the field of the Feldenkrais method. As research into this area is extremely limited, this investigation can serve as a basis for further research into the Feldenkrais method. Several areas for further research were demonstrated in the literature review and from the findings of this investigation. The question of how many ATM lessons are required before a significant effect is demonstrated on a variety of variables is an important area of study. In addition, there is still no definitive test used to assess hamstring muscle length on all patient types, and investigation of a hamstring length test suitable for flexible subjects while maintaining high validity would be of great use in both research and clinical environments.

Within its limitations, this investigation suggests that four Feldenkrais ATM sessions, including one aimed at lengthening the hamstrings (Wildman 1983c), were not effective in increasing hamstring length. It could be that the influence of the participants' belief in the Feldenkrais method needs investigation.

Conclusion
The current study investigated the effects of a Feldenkrais ATM program on hamstring muscle length. Within the confines of this study, it was found that the ATM lessons used were not effective in increasing hamstring length. Possible contributing factors to these findings were the inherent inefficiency of these techniques in altering hamstring length, insufficient exposure to the techniques, subjects' attitudes and perceptions, and low statistical power. Further research is needed into the effects of the Feldenkrais method before decisions can be made as to the efficacy of this method as a treatment technique.

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References
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