Does the Feldenkrais Method Influence Mobility?
A Scientific Exploration of Moshe Feldenkrais' "Awareness Through Movement"

Carolin Wipperfeld

Master Thesis – Talent Development & Creativity

S2895919
May 2023
Department of Psychology
University of Groningen
Examiner/Daily supervisor:
Dr. Laura S. Cuijpers

Abstract

Unbeknownst to most people, society, our family, and our social environment shape not only our personality, but also the way we move. We learn to move in ways that are functional and adaptive to our environment. However, this is not always sustainable in the long term. Moshe Feldenkrais developed a method to combat this. Sharing most of the theoretical groundwork with Dynamic Systems Theory, the Feldenkrais Method serves as a guide to become aware of suboptimal movement, to increase body awareness, and to explore optimal movement. In this study, we explored the effects of the Feldenkrais method on mobility in a weekend workshop. Based on our findings, no definitive predictions can be made and further studies on this matter are yet to be conducted. However, we found that a group-level analysis is not suitable for this kind of research and a more individual approach is suggested for any further research.

Keywords: Feldenkrais Method, Dynamic Systems Theory, Movement, Mobility, Group Level, Individual Level

Introduction

From the very first moments of our lives, even before we are born, our mothers will feel our attempts at coordinated movement as kicks and jabs in her belly. Very soon after birth, we start finding and coordinating our limbs in space. Before our parents know it, we can lift our heads and roll over. We start crawling and grabbing things with more accuracy. We pull ourselves up and learn to steady our small bodies. And not long after, we take our first little steps. As we grow older, our movements become more defined, and our speech more distinguished. We start to form social connections and learn to understand, regulate, and communicate our feelings and emotions. All of this happens naturally through trial and error. However, just as easily as we learn movement and coordination, we also ‘mislearn’ it.

Society, our families, and our social environment put pressure on us to adapt, to be ambitious, and to achieve, which greatly influences our development. In his 1979 article, Kessen described children as being a cultural invention, meaning that even as children, we are shaped in large part by our social environment. We develop in a way that is most functional for the environment we live in, which might, however, not be as functional in another environment. As we grow, we have to adapt time and time again and our development becomes less optimal. Many of us develop mental and physical problems later in life (World Health Organization, 2013), with older adults being at a higher risk of developing chronic illnesses (Anderson & Horvath, 2004). Against our very nature, many struggle with performing daily tasks and experience discomfort or even pain when doing so (IASP, 2020). Depending on the severity of the limitations, this can take a toll on people’s physical as well as mental well-being (Meehan & Carter, 2020). Some believe that the way we move, and especially our awareness of such movement, is closely tied to our physical health and mental states. Within cognitive science, this is called Embodied Cognition (EC) (Wellsby & Pexman, 2014). This class of theories stipulates that the way we interact with our physical environment and the sensorimotor experiences we gain from this interaction are essential for our cognitive development (Borghi & Cimatti, 2010). One strong defender of a very similar idea was Moshe Feldenkrais (1904-1984). He had taken interest in this topic after suffering a knee injury that, so doctors said, could not be treated surgically (Feldenkrais, 1987). Young Feldenkrais was not satisfied with that response and decided to take matters in his own hand. Unlike many people at this time, Feldenkrais, a man familiar with the linear thinking and accuracy of hard science, claimed that the brain was not, in fact, a hardwired machine. As an engineer, he was familiar with such machines and could tell that the human brain is far more malleable, a theory that would only be widely adopted decades later. We now call this neuroplasticity (Fuchs & Flügge, 2014). According to Feldenkrais, the brain and nervous system could be rewired, and maladaptive behaviours and movements could be unlearned, or rather re-learned. One simply needed to bridge that invisible gap between the brain and body and become aware of how one moves and then refine that newfound awareness. He claimed that this could alter brain structure and function and would ultimately help people function better in everyday life. And so, his idea that would lay the groundwork for the Feldenkrais method was born. Today, this method is practiced by many and a large amount of health professionals, researchers, and even famous athletes, such as the Major League Baseball Player Hunter Pence, hold Feldenkrais in high regard.

The Feldenkrais method itself consists of several simple exercises with the purpose of becoming more aware of the way we move and exploration of various movement patterns for increased physical and mental well-being. His book Awareness Through Movement (Feldenkrais, 1972) poses as a useful guide through the underlying theory as well as some exercises accessible to anyone. What follows is a short summary of that book for a better understanding of the method. At the centre of Feldenkrais' theory is the self-image. Feldenkrais claimed that a person's self is influenced by three factors, namely heritage, education, and self-education. Of these factors, only heritage is not changeable. It was his understanding that, naturally, a person develops according to their genetic make-up until society manipulates them into abandoning their natural tendencies in return for conformity and the resulting social status. Education is considered a relatively stable factor that is specific to a certain society and that aims to make people as similar to each other as possible. Lastly, Feldenkrais describes self-education as the factor that the individual has the most control over, depending on their characteristics and inherited personality. However, he believed that even self-education – which should encourage individuality – cannot entirely counteract the pressure put upon us by society. Therefore, most people abandon their natural tendencies and learn to live behind a mask of conformity, thereby endangering their physical and mental health. Feldenkrais further broke down a person's self-image into four components. These are movement, sensation, feeling and thought and are all to varying degrees present in any action taken by said person. He also claimed that the self-image is never static but while it is very fluent in childhood, it becomes more stagnant over time and changes become habits. These habits can be visualised by looking at the brain. The areas of the brain that are most developed indicate that a corresponding body part is used more frequently. These images of the brain differ greatly between individuals depending on their habits. Feldenkrais connected this to the self-image that according to him is often smaller than a person's potential. He claimed that a person making use of more cells and more combinations of cells is likely closer to their potential than a person using less. This then led him back to the previously mentioned limiting force that is society which, according to him, leaves most people using only about five percent of their true potential. This is in line with his observation that people's awareness of their body is very limited. Most people can clearly sense the body parts they use most in daily life but are more or less unaware of less actively used body parts. Feldenkrais then went on to say that, ideally, one would be aware of the entirety of one’s body and only that full awareness could be considered a complete self-image. However, since most people’s self-image never reaches an ideal state, they present themselves according to what they believe to be socially desirable. Feldenkrais suggested that the most effective way to counter this is not to correct single actions but to systematically correct a person’s self-image by means of increasing their body awareness.

After this introduction to the topic, Feldenkrais offers a range of simple physical exercises that do not require any tools and should be easy to do for anyone who does not have any major physical or mental impairments. Each exercise has a specific goal along with the overarching goal of improvement of posture, personal awareness, and physical and mental well-being. As most movement we practice daily is automatic, most exercises consist of moving certain body parts repeatedly, coordinating movement with the breathing, and becoming aware of how these movements are executed and how the body feels before, during and after. Feldenkrais claimed that even after practicing an exercise once, a change can be seen in a person’s posture, their mood, and the way they carry themselves. It is our aim to investigate these observations and to detect these changes described by Feldenkrais in our own study.

Dynamic Systems Theory

When Feldenkrais first developed his method, he described phenomena and scientific theory that had not been officially discovered or adopted by many at the time. Due to science not being as advanced then as it is now, his method was not entirely based on a solid scientific foundation and remained largely theoretical. Nowadays, there is scientific evidence for a lot of the theory described in his work. In this study, we are going to focus mainly on the Dynamic Systems Theory (DST) as the groundwork for the Feldenkrais Method.

The Dynamic Systems Theory stipulates that a system can be broken down into a multitude of smaller components that are in constant interaction with each other (Thelen and Smith, 1994). As the interaction of those components changes, the behaviour of the system as a whole changes as well. While Thelen and Smith (1994) acknowledge these constant changes, they argue that a system still tends to self-organize into what they refer to as an 'attractor state', a somewhat stable stage of behaviour. However, this attractor state is not always the most optimal but usually the most useful behaviour the system has available at a given time. Say, for example, a child is learning any form of locomotion. It is unlikely that the child will be able to carry out the behaviour immediately. Instead, it will go through several developmental stages, each defined by a new attractor state that depends on the child's physical and mental abilities at each stage as well as the attractor states the child has gone through previously (Thelen, 2005). None of these attractor states resemble optimal behaviour and yet are all crucial in the development of the child.

This theory shows compelling overlap with the Feldenkrais method (Buchanan and Ulrich, 2001). Both emphasise the importance of self-organisation of components within a system into considerably stable behaviour. While the Dynamic Systems Theory assumes that humans are constantly changing, self-organising systems, Feldenkrais believed that behaviour is acquired and not permanent (Buchanan and Ulrich, 2001), further confirming the theory. Despite differences in terminology, it was also Feldenkrais' opinion that a system self-organises into attractor states and that those states are often less than optimal. Given the non-permanent nature of human behaviour, Feldenkrais as well as supporters of the DST claimed that non-optimal behaviour could be changed by addressing the interaction of components responsible for the behaviour in question. Lastly, both theories assume that (human) systems are unique in that their behaviour is greatly influenced by their perception and their development until this point in time (Thelen and Smith, 1998). It is therefore advisable to look at systems individually rather than on a group level.

Current Study

The experiment for this study was designed to measure differences in self-awareness, mobility and balance between an experimental group that was given a Feldenkrais workshop and a control group. However, the current study will only focus on the mobility measures. Given that the Feldenkrais method is believed to improve i.a. posture and movement, we were curious to find out whether practicing the method would lead to improved mobility of the hip, shoulder, and spine, as compared to a control group that took part in a creative workshop.

Until recently, there has been very little scientific evidence to support the Feldenkrais method (Ernst & Canter, 2005; Hillier & Worley, 2015). Coming from a movement science/sport and performance psychology background, it is if utmost interest to us to shed some light on the usefulness of the method as it could prove very helpful to athletes and other movement specialists. As previously mentioned, humans (herein referred to as systems) are unique in their development and their behaviours. We will, therefore, be looking at the participants' individual development over a weekend workshop instead of comparing measures on a group level. Given the complexity of this study and a lack of valid measurement systems, our study will be of a rather exploratory nature in hopes of building a foundation for further research.

Methods

The experiment was conducted over two weekend workshops and two subsequent weekdays with the respective participants. On the first weekend, pre- and post-measurements of body awareness, mobility and balance were taken with a Feldenkrais workshop in-between. The Tuesday after, another round of post measurements was taken. While the structure of the second weekend and subsequent Tuesday were the same, the Feldenkrais workshop was substituted by a creative workshop as a means of creating a control condition.

Participants

The experimental group consisted of ten participants of which eight were female and two were male. Their ages ranged from 23 to 58 years. They were recruited by the researchers and through their networks, making them a convenience sample. The requirements for the participants were that they have no or only very little experience with the Feldenkrais method, are in reasonable physical and mental health and are proficient in the English language as the workshop as well as the instructions for the measurements were uniformly given in English. The control group was smaller with a size of five participants between the ages of 19 and 33 who were exclusively female. The requirements were the same with the exception of familiarity with the Feldenkrais method.

Measurement

All participants across both conditions had their measurements of body awareness, mobility and balance taken at five points in time (Saturday: pre- and post-workshop; Sunday: pre- and post-workshop; Tuesday). Through random assignment, half of the participants' balance was measured first, and the other half had their mobility measured first. The body awareness measurement was taken in a group setting. The participants' balance was measured by means of a Wii Balance Board using six different conditions (see Balance). Mobility was assessed by taking photographs of the participants doing relevant shoulder, hip, and spine mobility exercises (see Mobility). Lastly, body awareness was indicated by the participants themselves, using the Awareness Body Chart (ABC; Danner et al., 2017). This chart shows the front and back of a male or female body that could be colored in by the individual participants with each color denoting a different level of awareness (see Body Awareness).

Balance. For this measure, six different conditions were used that were counterbalanced between the participants to get a more accurate picture of the influence of the Feldenkrais method on balance. The participants were asked to stand still on a Wii Balance Board for 30 seconds in the following positions: both legs – eyes open, both legs – eyes closed; right leg – eyes open, right leg – eyes closed; left leg – eyes open, left leg – eyes closed. The Balance Board then measured their total force and Centre of Pressure (COP) which was recorded by the program BrainBlox. The recorded data were then converted into an Excel file.

Mobility. In this experiment, we were interested in the participants' mobility of the hips, shoulders, and spine. First, the participants' shoulder mobility was assessed by having them stand sidewards in front of a neutral background with their arm stretched out to the side in a 90-degree angle to the torso. They were given a short stick that they were asked to hold vertically (neutral position). They then rotated their arm forward and backward as far as possible, without changing the angle to the torso. The same three positions were then taken on the other side. For the hip mobility, the participants were asked to lay on their back with one of their legs in a 90-degree angle at the hip and the knee (neutral position), they were then instructed to rotate their leg inward and outward, keeping their thighs as still as possible. Additionally, an instruction was given to flex the foot to avoid inaccurate results caused by sickled feet. This was done on both sides of the body. Lastly, all participants were asked to sit at the edge of a stool, with their feet hip wide and their arms crossed in front of their body (neutral position). They then turned their upper bodies to both sides without moving their hips and legs. The participants' individual mobility could then be assessed by drawing straight lines through the relevant body parts on the photographs and subsequently comparing the respective rotation to the neutral position and/or a line parallel to or right through the center of the body.

Body Awareness. Lastly, the participants were asked to lay down, relax and feel their bodies for one minute. They then colored in the previously mentioned ABC sheet, using three colors to indicate their level of awareness of certain body parts, ranging from “clear/detailed awareness” to “unclear to no awareness”. An additional pencil was given to them to mark body parts in which they experienced pain. If they did so, they were asked to rate the pain on a scale from 0-100.

Procedure

As previously mentioned, all participants were recruited by means of convenience sampling. They all received an information email and were asked to sign an informed consent form. The experimental group was then invited to a weekend workshop at which their balance, mobility and body awareness was assessed pre- and post-workshop. In-between they were given two lessons from the book Awareness Through Movement (ATM, Feldenkrais, 1972) each day. The lessons were given by an instructor who has gained experience in the Feldenkrais method as part of his profession in behavioral science and movement education. Another round of measurements was taken two days after the workshop. No lessons were given that day. The control group was invited to a similarly structured weekend workshop, except they were not given Feldenkrais lessons but instead participated in a creative workshop. All measurements were taken in the same order as with the experimental group. None of the participants were compensated for their participation but were served fresh food and beverages.

Feldenkrais lessons

All Feldenkrais lessons were carefully chosen from Moshe Feldenkrais' book Awareness Through Movement. Each of them is explained in the following.

Lesson 3. This lesson is a very basic one as it teaches about the fundamental properties of movement and is therefore not specific to a certain body part. In this lesson, Feldenkrais instructs the person executing the exercise to first lie on their back, feel their body against the floor and try to determine whether there are any differences between the sensations in both sides of the body. One is then asked to execute small movements with the arms, legs, and head and to coordinate these movements with the breathing. Feldenkrais claims that through repetition, one will automatically start to use not the smaller muscles of the limbs but to decrease the effort by using the larger muscles towards the centre of the body. After every set of repetitions, the subjects are asked to relax and become aware of their bodily sensations. Movement is believed to be more fluent and effortless after practicing this exercise.

Lesson 5. This lesson focuses on the extensor muscles of the back and the flexor muscles of the abdomen. In a lying position either the arms or legs will be moved to one side of the body, or the upper body will be rocked from side to side, creating a rotation in the torso. Feldenkrais recommends repeating each exercise several times (approx. 25 times each). He claims that these exercises will help lengthen the muscles needed for rotation of the upper body, support balance of the head and improve the differentiation of head and torso movement.

Lesson 6. The focus of this exercise lies in the differentiation of pelvic movements. This is done by having participants lie on their back and perform small movements with their pelvis. Feldenkrais uses the image of a clock to describe these (circular) movements. Participants are, for example, asked to rotate their pelvis along an imaginary clock dial, having the pelvis touch the ground at each point that marks an hour. The main idea here is to refine pelvic movement and to improve the posture of the spine. Furthermore, this lesson is supposed to help the participants improve the rotation of their spine in an erect position, facilitating location and coordination of their limbs in space.

Lesson 10. This last lesson focuses mostly on the movement of the eyes and how this movement influences the coordination of the body. It consists in large part of rotating movements of the body in different positions, eyes open or shut, turned to the same side as the body or the other. The idea is to distinguish movement of the eyes from movement of the rest of the body, specifically that of the neck. The participants learn to separately use the muscles of the eyes and those of the neck to ultimately make body movement easier and more fluent.

Statistical analyses

As a thorough analysis of all collected data is far beyond the scope of this thesis, several broader analyses were conducted to take a first step into the exploration of the effects of the Feldenkrais method on the human mind and body. It was our goal to create a study and to generate results that can be built upon in further research.

As a first step, the data was analysed by means of graphs to visualise general patterns on a group level. These graphs also serve as a foundation for the interpretation of any further statistical analyses. In the next step, we conducted a repeated measures ANOVA, using the five points in time that each measurement was taken as the within-subject factors. The results then showed whether there are any significant differences in mobility between the time-points. Subsequently, pairwise comparisons were conducted. Lastly, we took a closer look at some of the data on an individual level to be able to make more accurate predictions about the effectiveness of the Feldenkrais method.

Results

One participant of the experimental group did not take part in all four Feldenkrais lessons due to a medical condition. However, all participants completed the five measurement sessions. The mean results ranged from 56.85 degrees (SD=14.34) to 61.75 degrees (SD=13.41) for Hip, from 239.45 degrees (SD=48.47) to 302.55 degrees (SD=33.82) for Shoulder, and from 182 degrees (SD=40.81) to 198.8 degrees (SD=34.34) for Spine. There appears to be an upward trend in hip and shoulder mobility scores over time. The scores for spine mobility appear to be random. The data of two participants suggested that they had misunderstood the instructions for the shoulder mobility in the first session, making the difference between sessions 1 and 2 unrealistically large. The values for the first session have therefore been removed for those two participants and were not included in the subsequent analyses.

All participants in the control group completed all five measurement sessions. The results ranged from 58.4 degrees (SD=11.78) to 63.9 degrees (SD=5.52) for Hip, from 286.4 degrees (SD=35.77) to 303.7 degrees (SD=37.55) for Shoulder, and from 212.6 degrees (SD=30.2) to 246.8 degrees (SD=17.46) for Spine. The results of shoulder and spine mobility show an increase over time, while the hip mobility does not suggest a clear pattern. The first measure of hip mobility was not recorded for participant 3 of this group. The group average of this measure was therefore computed from the remaining four participants and was used as such for all analyses.

An independent samples t-test was conducted for the first session of all three mobility measures to ensure that any potential significant results are not the result of initial group differences. According to the results, there are no significant differences between the experimental group and the control group in hip mobility ($t(12)=-.671$, $p=.515$), shoulder mobility ($t(11)=-1.442$, $p=.177$), and spine mobility ($t(13)=-.761$, $p=.460$), in the first session.

Group Level

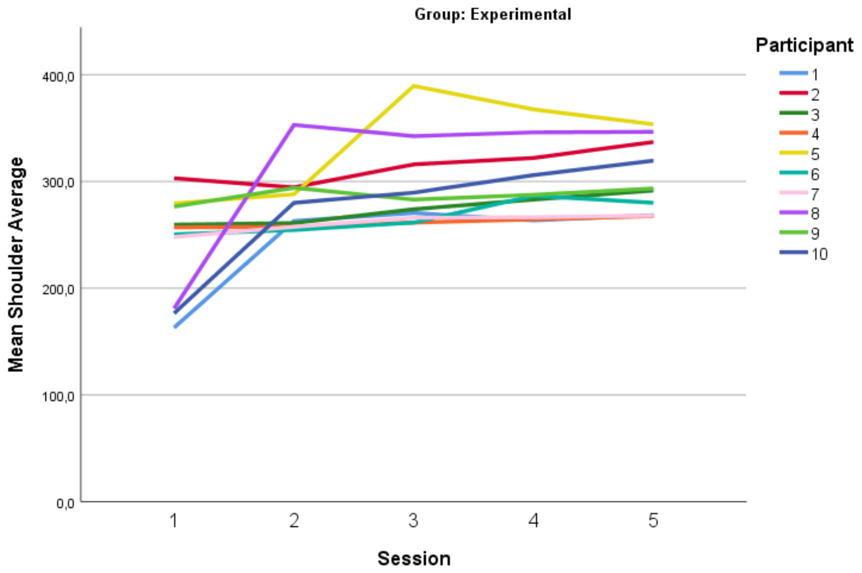
The data was first analysed on a group level and a repeated measures ANOVA was conducted to test whether there were significant differences in mobility group average between across the five sessions. For this analysis, the dataset was split into 1=Experimental and 2=Control, and also into 1=Hip, 2=Shoulder, and 3=Spine. The results of Mauchly's test of sphericity suggested that the assumption of sphericity was violated for shoulder mobility in the experimental group ($\chi^2(9)=22.415$, $p=.01$). The combination of control – hip did not give any results for chi-square and significance, as the sample size was smaller than the number of repeated measures, due to a missing value. For both, the Greenhouse-Geisser significance value was used to determine possible differences between group means.

Significant differences were found for experimental – shoulder ($F(1.75, 12.24)=5.625$, $p=.021$), experimental – spine ($F(4, 32)=3.675$, $p=.014$), and control – spine ($F(4, 16)=4.961$, $p=.009$), at an alpha level of .05. To further determine where those differences lie exactly, a pairwise comparison was conducted for all three aforementioned conditions. To minimise the chances of a Type I error, the Bonferroni correction was used. After the application of this correction, no significant results could be found.

As can be seen in a visual representation of the data, there is an increase in mobility for experimental – shoulder (see figure 1) and control – spine (see figure 2). The mean spine mobility of the experimental group decreased in Session 2 and then increased again (see figure 3). This is in line with the findings of the repeated measures ANOVA. The other graphs do not show any specific patterns.

Figure 1

Degrees of Shoulder Mobility Average by Session by Participant of Experimental Group



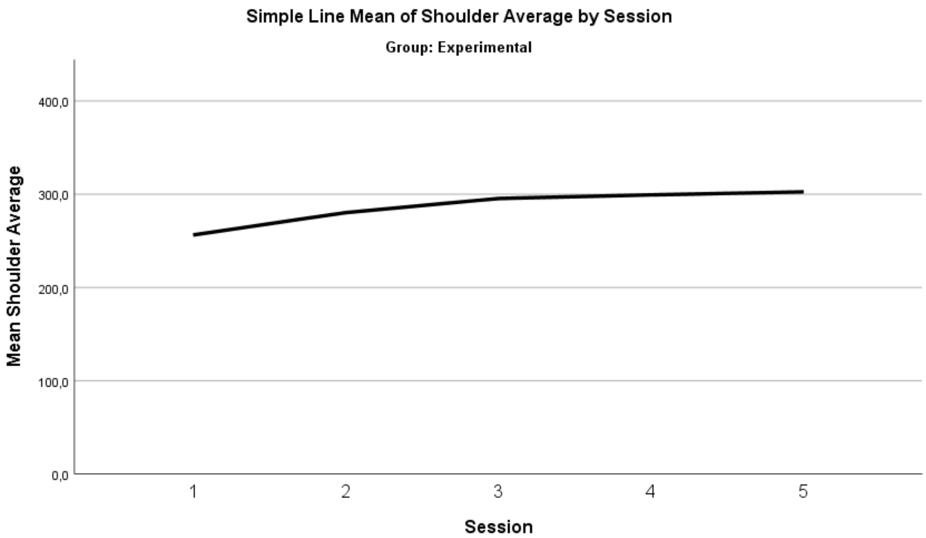


Figure 2

Degrees of Spine Mobility by Session by Participant of Control Group

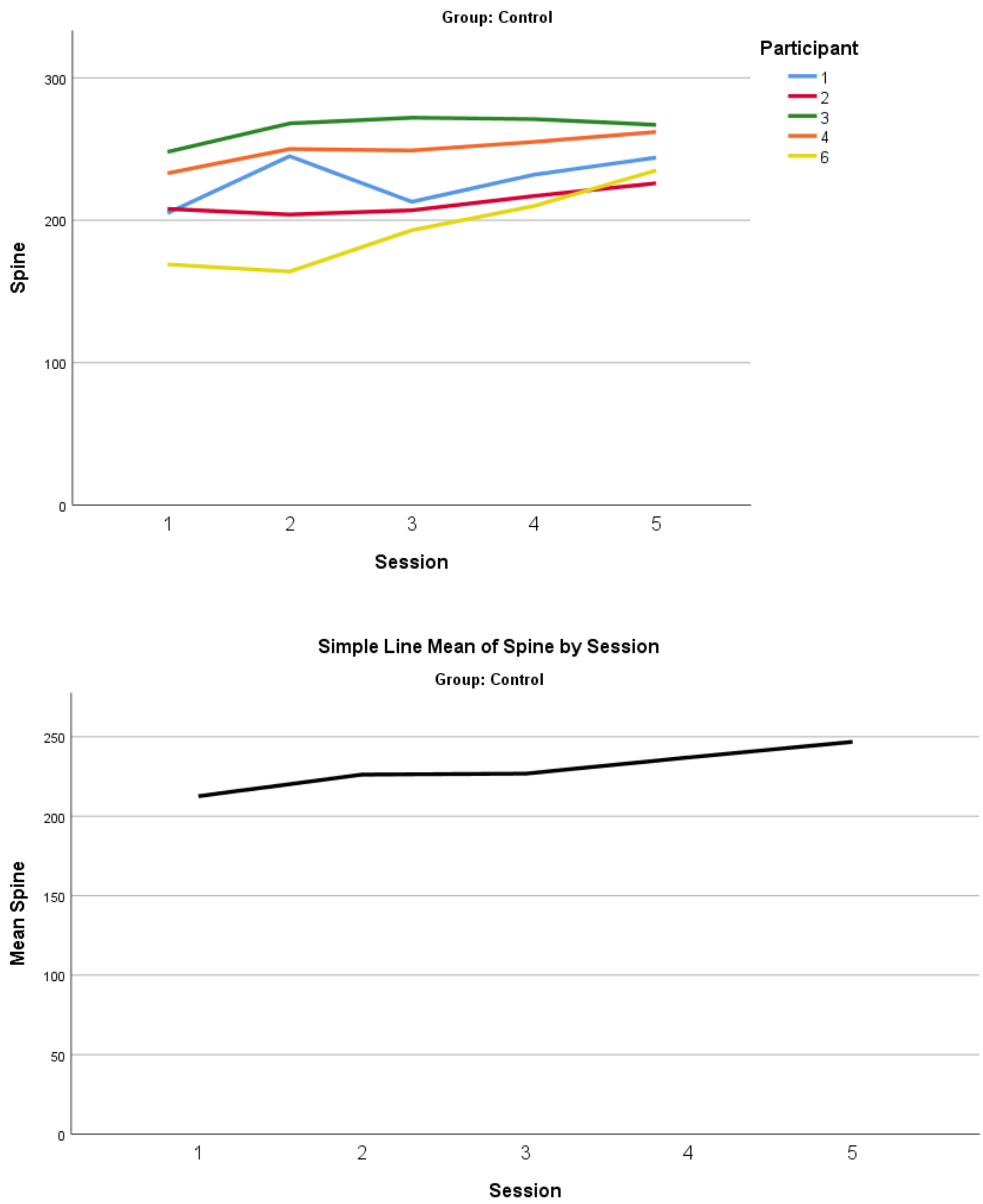
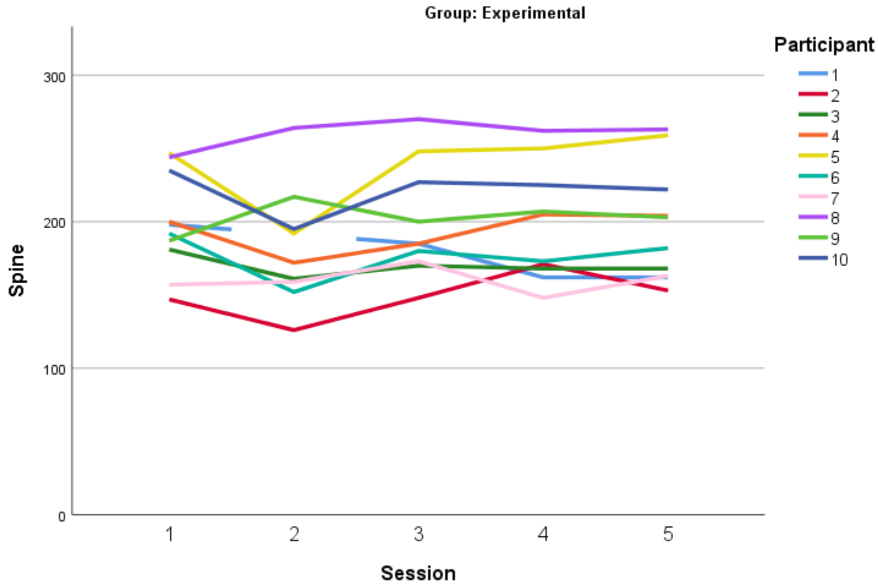
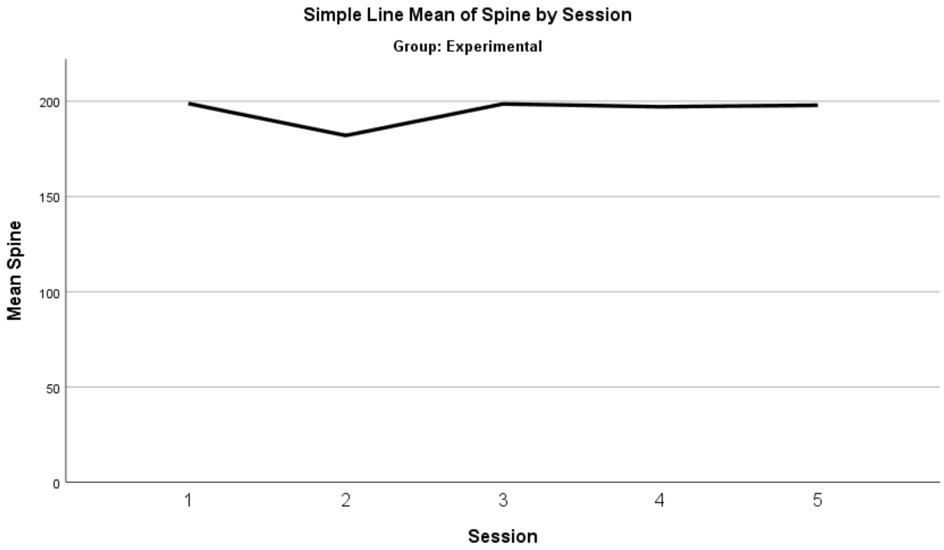


Figure 3

Degrees of Spine Mobility by Session by Participant of Experimental Group



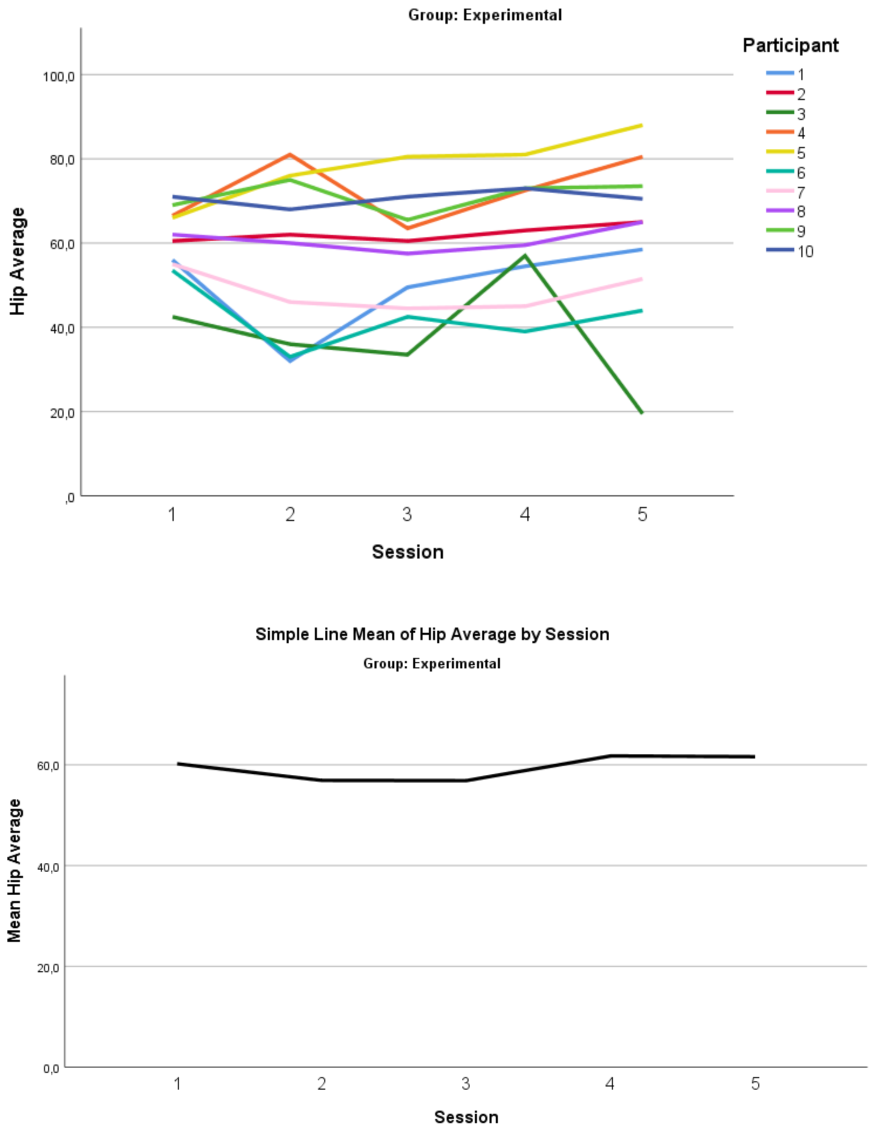


Individual level

As mentioned previously, it is advised to look at (human) systems individually, rather than on a group level, because the development of a single system is unique and dependent on the system's previous development. Therefore, we analysed the data by means of graphs, showing every participant's individual development over the course of five points in time. As can be seen in those graphs, there does seem to be a general trend that most individuals of either group follow, however, they do vary in their development over time. This becomes most apparent in the experimental – hip condition (see Figure 4). It appears that there is a slight upward trend, suggesting an improvement of mobility, though every trajectory follows a different pattern.

Figure 4

Degrees of Hip Mobility Average by Session by Participant of Experimental Group



Similarly, there is only a slight increase in shoulder mobility for most participants in the experimental group, however, some participants' mobility increased drastically at once and then steadied over time (see Figure 1). This is in line with the results of the repeated measures ANOVA, suggesting significant differences across the five sessions for experimental – shoulder. Significant results were also found for experimental – spine. The graph for this condition shows a large variation in the development of mobility (see Figure 3). There does not seem to be a general upward or downward trend, but a decrease in mobility in the second session can be seen in several participants. This follows the pattern of the group level of mobility over time. Lastly, the graph for the third significant condition, control – spine, shows a steady increase in mobility for almost all participants, which is similar to the visual analysis on the group level (see Figure 2).

Overall, it can be said that while the variation around the mean of the control group is rather steady or even decreases over time, the opposite is the case for the experimental group for the hip and shoulder measurements. The variation in spine measurements does not seem to change much over time. This was visualised by means of boxplots in Figures 5-7.

Figure 5

Degrees of Hip Mobility Average by Session by Group

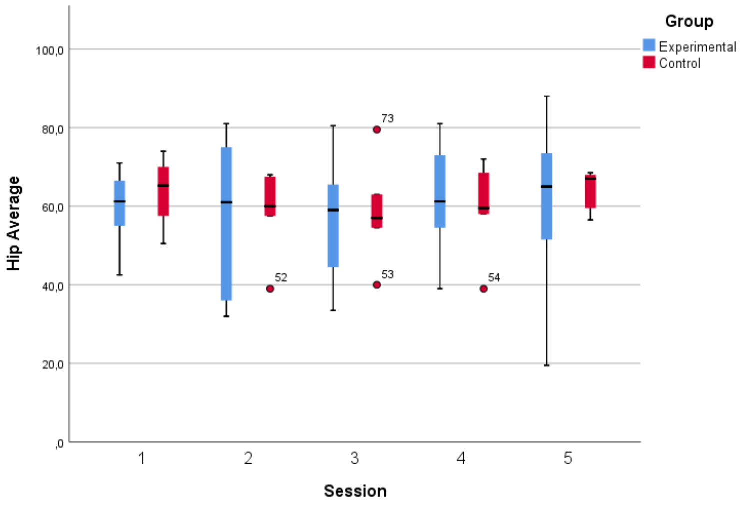


Figure 6

Degrees of Shoulder Mobility Average by Session by Group

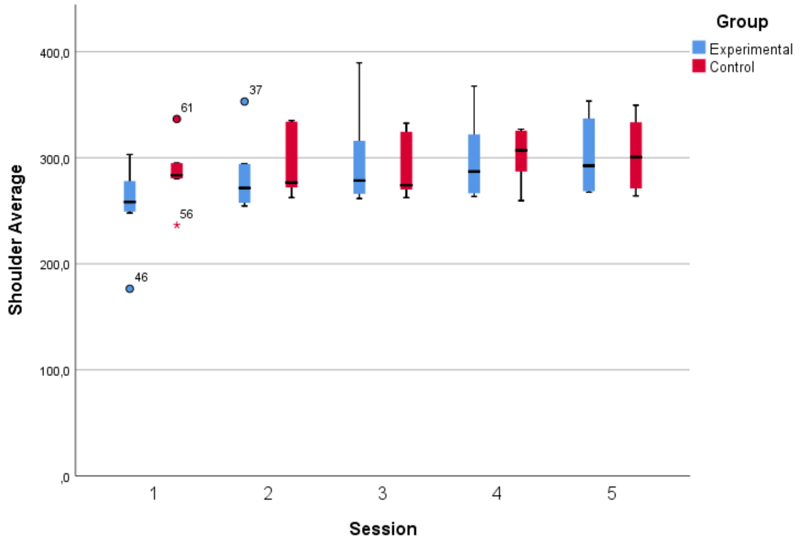
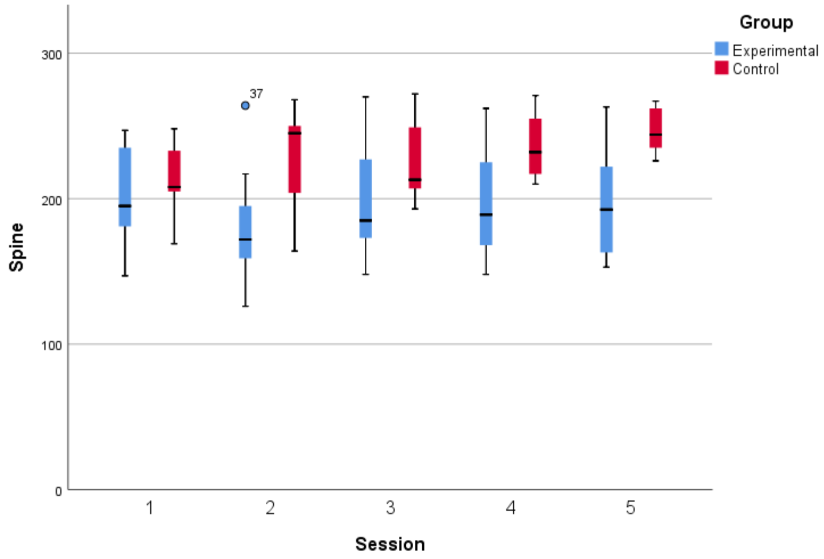


Figure 7

Degrees of Spine Mobility by Session by Group



Discussion

The aim of this study was to explore the effects of the Feldenkrais method as described in 'Awareness Through Movement' on body awareness, balance, and mobility. This thesis focused specifically on changes in mobility before and after intervention.

Feldenkrais created this method claiming that movement could be relearned, and body awareness could be improved through movement. It was his opinion that rather than moving naturally, we learn to move in a way that is adaptive, as society shapes us over the course of our lives. In dynamical systems theory, this is described as a system – herein the human body – organising itself into attractor states. This state enables the system to work in a way that is functional, which is not always synonymous with optimal . In reality, these attractor states are often practical in the moment of organisation but not sustainable in the long term. Feldenkrais was of the opinion that suboptimal movement can cause problems with the body and the mind. His method is said to combat these problems and aid people in exploring optimal movement. If this is true, the Feldenkrais method could and should become a crucial part of athletes' training regimen as well as people's everyday lives. Therefore, it was our aim to put the usefulness of the Feldenkrais method to the test.

A repeated measures ANOVA on a group level did show significant results for two measures in the experimental condition and one in the control condition. A pairwise comparison, however, did not yield any significant results. One possibility is that there was a lack of statistical power as a result of a small sample size. A pairwise comparison with low statistical power is less likely to produce significant results. Therefore, it is advisable to make use of larger samples in any future research on this matter. Another possibility is that the pairwise comparison did not detect any significant differences because the global effects were rather weak, meaning that the p-values of the repeated measures ANOVA were close to the significance level of $\alpha=.05$. The Bonferroni correction that was applied to the data in the pairwise comparison is used to adjust the p-value in order to decrease the chance of a Type I Error. It is possible that significant effects would have been detected, had we not used the Bonferroni correction. However, the risk of a false positive would have been unacceptably high.

A visual analysis of the data showed a slight upward trend for experimental – shoulder and control – spine, which are also two of the three conditions for which the repeated measures ANOVA produced a significant effect. This suggest that there was an increase in mobility over time that is not exclusive to the experimental group, suggesting that mobility can be improved in multiple ways. This leaves the question why mobility increased, nonetheless. Often, people are (slightly) tense when they find themselves in unfamiliar situations, e.g. new environments, meeting new people. Also, being a research participant and having one's measurements taken might be a strange situation to some people. This could have caused some participants to be less mobile in the earlier measuring sessions. These same participants might have become more relaxed as they familiarised themselves with the situation and the group, increasing mobility through relaxation rather than through the Feldenkrais method. However, if this were the case, the question would remain why only shoulder and spine mobility improved for the experimental and control group, respectively.

Given that shoulder mobility increased for the experimental group and spine mobility increased for the control group, it is also possible that these effects are entirely random. Though, one could also speculate that the increase in spine mobility in the control group occurred purely by chance and that the Feldenkrais lessons did have an effect on shoulder mobility, even if small. As the Feldenkrais lessons target different areas of the body, it is possible that only shoulder mobility improved due to the selection of Feldenkrais lessons. This would mean that other lessons could prove more useful in targeting hip and spine mobility.

Interestingly, the significant effect in the experimental – spine condition is likely due to a decrease in mobility in the second session. This can be seen on both the group level and the individual level. Several participants appeared to have lower spine mobility in the second session. This is peculiar for two reasons. First, because the second session took place after the first two Feldenkrais lessons, implying that if anything, the Feldenkrais lessons had a negative effect on spine mobility. Not only does this falsify the hypothesis that the Feldenkrais method is useful in improving mobility, but it also suggests the possibility of adverse effects. This should be subject to further research. Secondly, the second round of measurements took place in the afternoon. As people are usually less flexible after waking up, it is to be expected that, generally, mobility is higher in the afternoon. However, the opposite was the case, further reinforcing the notion that at least one of the given Feldenkrais lessons had an undesired effect on spine mobility.

Overall, the Feldenkrais method appears to have had an effect that remains to be explained. The individual-level graphs of the control group suggest that the participants did not differ much from each other in the development of their mobility over time. Looking at the individual lines, they seem to be behaving much in the same way and there are not many fluctuations. The individual trajectories of the participants of the experimental group show a lot more variation. This could be due to the difference in sample size between the two groups. However, this also confirms that there are still issues with the analysis of individual trajectories in a study like this.

Limitations and future research

As this study is exploratory in nature, we do not assume the presented results to be scientific evidence for the usefulness of the Feldenkrais Method. It was solely our intention to find out whether there could be any positive changes in mobility after practicing the method and to therewith lay a foundation for future research. Unfortunately, there is still a serious lack of valid measurement tools and systems that would have been suitable for this study. We, therefore, made use of a test that had previously been conducted in a similar study (Gort, 2020). This test includes taking pictures of test subjects in different positions pre- and post-intervention and to then calculate the difference in mobility by means of measured angles to a neutral pose or reference line. However, there are no clear instructions as to how the pictures should be taken and how the angles should be measured exactly. In our study, we used tape on the ground and walls as well as a tripod in a fixed position to acquire uniform pictures for increased accuracy. However, it proved difficult to give the same instructions to all participants and have them execute the exercises in the exact same manner. This is likely because 1) each individual's body is unique and 2) so is their proprioception and the way they move in space. Notwithstanding our efforts to create uniform images, there are some minor differences between and even within participants with regard to execution of the exercises. Another issue was the measuring of the angles as all angles had to be drawn by hand, allowing for human error. This means that the results are likely not entirely accurate. We do, however, assume that they do reflect reality to a satisfactory degree. Although difficult to realise, a measurement tool would have to be developed that can stand the test of validity and reliability to scientifically prove or disprove the usefulness of the Feldenkrais Method in future research.

Furthermore, we made use of convenience sampling as the acquisition of participants for our rather time-intensive study proved difficult. The sample was rather small with 10 participants in the experimental group and 5 participants in the control group. As previously mentioned, a sample this small is less likely to produce any significant effects. Therefore, we suggest that a larger sample be used in future research. All participants could choose freely which workshop they wanted to take part in. This means that our data could have been subject to selection bias, as the assignment of participants to their respective groups was not random. In the future, sample selection should be truly random.

Our analyses did produce visible effects; however, the reported results leave plenty of room for additional research. This line of research is worth exploring further with improved measurement tools and thorough analyses of individual trajectories. We suggest that the limitations of our study be considered in future studies to make more accurate predictions.

Finally, the title of Feldenkrais' book suggests that awareness is reached through movement. Assuming that this is true, and that a positive influence of the Feldenkrais method on mobility can be proven in future research, the question remains whether a correlation or perhaps even causal relationship exist between the two. This should be subject to further investigation.

Conclusion

As yet, no definitive statements about the effects of the Feldenkrais method on mobility can be made, but it should be noted that that was not the objective of this paper. Instead, it was our aim to explore the effects of the Feldenkrais method on mobility and to lay a foundation for future research. The results of our analyses are ambiguous in that a repeated measures ANOVA did produce significant effects, none of which could be confirmed in a pairwise comparison. A visual analysis shows large variations in the data but suggests an upward trend in mobility over time. However, this is true for both the experimental and the control group. We suggest that in future studies data of subjects randomly assigned to their respective conditions be collected in a more precise manner and be analysed on an individual level in a longitudinal study design.

References

Anderson, G., & Horvath, J. (2004). The growing burden of chronic disease in america. *Public Health Reports (Washington, D.c. : 1974), 119*(3), 263–70.

Borghi, A. M., & Cimatti, F. (2010). Embodied cognition and beyond: acting and sensing the body. *Neuropsychologia*, *48*(3), 763–773. doi:10.1016/j.neuropsychologia.2009.10.029

Buchanan, P. A. & Ulrich, B. D. (2001). The Feldenkrais Method: A Dynamic Approach to Changing Motor Behavior. In *American Alliance for Health, Physical Education, Recreation and Dance* 4, pp. 315–323.

Danner, U., Avian, A., Macheiner, T., Salchinger, B., Dalkner, N., Fellendorf, F. T., Birner A., Bengesser, S. A., Platzer M., Kapfhammer HP., Probst M. & Reininghaus, E. Z. (2017). "ABC"-The Awareness-Body-Chart: A new tool assessing body awareness. In *PloS one* 12, e0186597. DOI: 10.1371/journal.pone.0186597.

Ernst E., Canter P. H. The feldenkrais method—a systematic review of randomised clinical trials. *Physikalische Medizin Rehabilitationsmedizin Kurortmedizin.* 2005;15(3):151–156. DOI: 10.1055/s-2004-834763. (Ger).

Feldenkrais, M. (1972). Awareness Through Movement: health exercises for personal growth.

New York: Harper and Row

Feldenkrais, Moshe. (1987). Awareness through Movement. 1st ed. New York: Harper and Row

Fuchs, E., & Flügge, G. (2014). Adult neuroplasticity: more than 40 years of research. *Neural Plasticity*, 2014, 541870–541870. DOI: 10.1155/2014/541870

Gort, S.J. (2020). Zoektocht in Beweging: Het Effect van de Feldenkrais Methode op het

Domein Mobiliteit. [Bachelor Thesis, Rijksuniversiteit Groningen]

Hillier, S., & Worley, A. (2015). The Effectiveness of the Feldenkrais Method: A Systematic Review of the Evidence. *Evidence-Based Complementary and Alternative Medicine* (2015), 1-12. DOI: 10.1155/2015/752160

IASP (2020). Revision of the International Classification of Diseases (ICD11). Available online at: https://www.iasppain.org/Advocacy/icd.aspx?ItemNumber=5234&navItemNumber=5236

Kessen, W. (1979). The American child and other cultural inventions. *American Psychologist,* *34*(10), 815–820. DOI: 10.1037/0003-066X.34.10.815

Meehan, E. & Carter, B. (2020). Moving With Pain: What Principles From Somatic Practices Can Offer to People Living With Chronic Pain. In *Frontiers in psychology* 11, p. 620381. DOI: 10.3389/fpsyg.2020.620381.

Thelen, E. (2005). Dynamic Systems Theory and the Complexity of Change. In *Psychoanalytic Dialogues* 15, pp. 255–283. DOI: 10.1080/10481881509348831.

Thelen, E. & Smith, L. B. (1994). A dynamic systems approach to the development of cognition and action. Cambridge, Mass., London: MIT Press (MIT Press/Bradford Books series in cognitive psychology).

Thelen, E., & Smith, L. B. (1998). Dynamic systems theories. In W. Damon & R. M. Lerner (Eds.), *Handbook of child psychology: Theoretical models of human development* (pp. 563–634). John Wiley & Sons Inc.

Wellsby, M., & Pexman, P. M. (2014). Developing embodied cognition: insights from children's concepts and language processing. *Frontiers in Psychology*, *5*, 506–506. DOI:10.3389/fpsyg.2014.00506

World Health Organization. *Mental health and older adults.* 2013 Retrieved from http://www.who.int/mediacentre/factsheets/fs381/en/

Appendix

Descriptive Statistics

Figure A1

Descriptives of Hip Average on Group Level by Session

	Group	*N*	*Lowest*	*Highest*	*Mean*	*Std. Deviation*
Experimental	S1	10	42.5	71	60.2	8.65
	S2	10	32	81	56.4	18.79
	S3	10	33.5	80.5	56.85	14.34
	S4	10	39	81	61.75	13.41
	S5	10	19.5	88	61.6	19.7
Control	S1	4	50.5	74	63.75	9.77
	S2	5	39	68	58.4	11.78
	S3	5	40	79.5	58.8	14.33
	S4	5	39	72	59.4	12.84
	S5	5	56.5	68.5	63.9	5.52

Descriptives of Shoulder Average on Group Level by Session

	Group	*N*	*Lowest*	*Highest*	*Mean*	*Std. Deviation*
Experimental	S1	8	176.5	303	256.31	37.05
	S2	10	254.5	353	280.3	30.02
	S3	10	261.5	389.5	259.4	42.07
	S4	10	263.5	367.5	299.3	35.79
	S5	10	267.5	353.5	302.55	33.82

Control	S1	5	236.5	336.5	286.4	35.77
	S2	5	262.5	335	296	35.51
	S3	5	262.5	332.5	292.7	33.06
	S4	5	259.5	327	301.2	28.42
	S5	5	264	349.5	303.7	37.55

Descriptives of Spine on Group Level by Session

	Group	***N***	***Lowest***	***Highest***	***Mean***	***Std. Deviation***
Experimental	S1	10	147	247	198.8	34.34
	S2	9	126	264	182	40.81
	S3	10	148	270	198.6	38.15
	S4	10	148	262	197.1	39.02
	S5	10	153	263	197.9	39.84
Control	S1	5	169	248	212.6	30.2
	S2	5	164	268	226.2	41.92
	S3	5	193	272	226.8	32.64
	S4	5	210	271	237	25.66
	S5	5	226	267	246.8	17.46